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ESTIMATES OF THE MINIMUM NUMBERS OF GENES DIFFERENTIATING SEVERAL TAXONOMIC CATEGORIES IN THE GENUS SOLIDAGO*

RICHARD H. GOODWIN

Intensive genetic investigations have shown that a very large number of distinct gene loci may be identified within a single species. In *Drosophila melanogaster*, for example, this figure undoubtedly exceeds 480 (Bridges & Brehme 1944); in maize, 300 (Emerson, Beadle & Fraser 1935). A large number of these genes, however, are recessives which appear only rarely in the wild. Cultivation and domestication drastically alter the forces normally operating upon a natural population, and special experimental methods have recently been employed (Dobzhansky & Epling 1944; Clausen, Keck & Hiesey 1940) to bring out latent genetic variability which normally would remain undetected. The total number of genes present within the nucleus and in operation during the development of any particular species has never been determined, and only very crude estimates have been hazarded at this figure.

Another type of estimate is of considerable interest, however. The vast array of organisms confronting the student of natural history has been studied and subdivided into a series of systematic categories—phylum, class, order, family, genus, species, subspecies, form, etc. The validity of the concept of descent with modification, resulting in natural relationships at various taxonomic levels, suggested by the above-mentioned terms, is universally accepted, although there is frequently a wide divergence of opinion with respect to the definition of these categories and their interpretation. The question which we wish to discuss here is the problem of estimating the number of gene loci involved in differentiating lines of descent at various taxonomic levels. At the present time the methods of getting at this problem are genetic and involve breeding experiments between related forms. Since intergeneric crosses are rare and usually sterile, estimates above the species level can only be made very exceptionally, and even at that level, can only be made in certain favorable cases. Estimates within a species can readily be obtained.

On the basis of genetic studies begun about ten years ago, minimal estimates have been made of the number of gene loci involved in differentiating a few lines of descent within the genus *Solidago*. Two of these lines are recognized as belonging to distinct species; two as distinct subspecies; and two as distinct strains of the same subspecies. The general procedure has been the

* The tables are published with assistance from the Lucien Marcus Underwood Memorial Fund.

collection of a few sample *Solidago* specimens from natural populations at widely separated geographic localities. These plants have been grown for a number of years in the greenhouse and also under field conditions in an experimental garden. During this period various character differences have been noted. Certain crosses have been made between these stock plants, and F_1 and F_2 hybrid populations have been raised and analysed.

Wright (in Castle 1921) has developed a method of estimating the number of gene substitutions which determine a difference in some measurable character between two isogenic strains, if numerous individuals of each strain and of their F_1 and F_2 have been measured with respect to that character. The method is indicated by the following formula, in which $\bar{v}_P$ and $\bar{v}_p$ represent the average measurements of the parental strains, σ_1 and σ_2 the standard deviations of the F_1 and F_2, and n the number of gene differences:

$$n = \frac{(\bar{v}_P - \bar{v}_p)^2}{8(\sigma_2^2 - \sigma_1^2)}$$

This formula gives a minimal estimate and is based on the assumptions (1) that each strain is isogenic with respect to the character studied, (2) that the large-size genes are concentrated in one strain, the small-size genes in the other, (3) that the genes involved have equal or additive effects (at least upon proper choice of scale), without dominance or epistasis, and (4) that no two of the loci are in the same chromosome. If these assumptions do not match the actual conditions in the material to which the method is applied, the estimated number of gene differences will be smaller than the actual number. In any event a minimal estimate will be obtained.

In cases where more than one character is involved, some of the genes may have manifold effects. On the basis of assumptions 1, 3, and 4, mentioned above, the following formula for estimating the maximum number of genes influencing the phenotypic expression of any two characters has been derived (Charles and Goodwin 1943):

$$n_L(1-2c) + n_C = \frac{\Delta x \Delta y\ (r_2 R_x R_y - r_1)}{8(R_x^2 - 1)\ (R_y^2 - 1)}$$

where

n_L = the number of character-x loci each linked with a character-y locus.
c = the average crossover value between linked pairs of genes.
n_C = the number of genes acting on both characters.
Δx = the difference between parents in average value of character x, divided by the standard deviation of that character in F_1.
Δy = the analogous quotient for character y.
R_x = the standard deviation of character x in the F_2, divided by the standard deviation of character x in the F_1.
R_y = the analogous character-y quotient.
r_1 and r_2 = the correlation coefficients between characters x and y in the F_1 and F_2 respectively.

The right-hand member of this formula may be computed for a given character pair, but there is no ready way to determine the proper values of the number of linked and the number of common genes. For purposes of making a *minimal* estimate of the total number of genes involved in a given cross, however, it is safe to take the value of the total common genes (n_C) as equal to the nearest integer below the exact value for the combined expression $n_L(1-2c)+n_C$.

The biological material used in these studies belongs to two species complexes. The *Solidago rugosa* complex includes goldenrods of open woods and clearings, thickets, fencerows, and roadsides, and is widespread throughout eastern North America from Newfoundland to Texas. Fernald (1936) writes that "probably no aggregate-species of *Solidago* in America, unless it be the *canadensis* group, is more baffling in its variations than *S. rugosa* Mill." He then proceeds to delimit a series of races which he considers to be of subspecific rank. There is no question that much experimental work, patterned after the comprehensive studies of Clausen, Keck and Hiesey (1940), needs to be done to clarify the status and limits of this complex and its components, as will be exemplified by results to be discussed later in this paper. A single sample representing Fernald's *S. rugosa* var. *typica*[1] was collected in Belmont, Massachusetts, for experimental purposes.

Solidago sempervirens, as now interpreted by American authors, is a maritime species, growing in brackish marshes and along sandy or rocky shores all the way from Newfoundland to Mexico. It includes northern and southern races which are morphologically distinguishable, and which Linnaeus (1753), and others before him, regarded as being specifically distinct. Certain systematists (Small 1933; Friesner 1933; Buswell 1942) apparently regard the differences between these races as of no taxonomic significance. Fernald (1935), however, basing his decision upon field observations and herbarium studies, considers these forms to be pronounced "geographic varieties," of subspecific rank.[1] The range of the northern form, his var. *typica*, overlaps that of the southern var. *mexicana*, from Massachusetts to Virginia. In the region of overlap he states that the two subspecies appear to be ecologically separated, *typica* inhabiting the exposed, saline outer beaches, *mexicana* the sheltered, less saline estuaries and marshes. I have not made extensive field studies in this area myself, but consider that extensive collecting might prove very illuminating. Plants used in the present investigation were obtained from three stations along the coast. Var. *typica* was collected at Ipswich, Massachusetts; var. *mexicana*, from Ocean City, Maryland, and from Fort Myers, Florida.

Natural hybridization may occur between *S. rugosa* and *S. sempervirens*, where individuals of both species happen to grow in close proximity to one

[1] For a discussion of Fernald's use of the term variety, see R. T. Clausen (1941).

another. Favorable localities are rather infrequent and occur chiefly where ecological conditions have been upset by the hand of man (see Wiegand 1935). In one such locality which has been intensively studied (Goodwin 1937a, 1937c) extensive hybridization and backcrossing has resulted in an extremely polymorphic population.

Artificial crosses have been made between *S. sempervirens* and *S. rugosa*, and fertile F_1 and F_2 hybrids have been obtained (Goodwin 1937c). As might be expected, the number of chromosomes is the same in both species, and cytological studies reveal normal meiotic behavior in the F_1 hybrids.

From a subsequent analysis of the parental and hybrid populations (Charles & Goodwin 1943) with respect to six differentiating leaf-characters, the numbers of genes determining each character difference, and maximal numbers of genes acting on both members of each character pair were estimated. It was concluded that a minimum of 21 genes might account for these character differences. Other morphological differences in the inflorescence and the vegetative axis were not analyzed. Some of them might be attributed to the manifold action of some of the 21 leaf-character genes; but it seems almost certain that the *actual* total number of gene substitutions involved in differentiating *S. sempervirens* from *S. rugosa* is considerably greater than this *minimal* estimate—possibly in the neighborhood of 40 genes.

From the foregoing discussion, it should be clear that *rugosa* and *sempervirens* are closely related members of a species complex in which species delimitation becomes a perplexing problem. Dobzhansky (1935) has defined a species as that stage of the evolutionary process "at which the once actually or potentially inter-breeding array of forms becomes segregated in two or more separate arrays which are physiologically incapable of interbreeding." In an illuminating discussion of this definition in the concluding chapter of his book *Genetics and the Origin of Species* (1937), he makes the following statement which is applicable in the present case: "In some instances hybrids between species are observed mainly in localities modified by man's activity (Wiegand 1935). The physiological isolating mechanisms that have kept these species separate (presumably ecological isolation) prove inadequate when the conditions have changed due to the introduction of new factors. So long as a complete physiological isolation has not developed, the process of evolution is partly reversible: once discrete groups may become fused again into a single one." The foregoing genetic analysis has shown that the numerous morphological differences between *rugosa* and *sempervirens* are each controlled by a battery of genes. This indicates that speciation has reached a fairly advanced stage. To reduce *rugosa* and *sempervirens* to two very dissimilar ecotypes (Turesson 1922) of the same species would do violence to the species delimitations of these goldenrods as interpreted by every taxonomist who has worked with the genus to date.

TABLE 1. *Floret number and fruit length in S. sempervirens vars. typica and mexicana.*
Means and standard deviations are given when available. Extremes are in parentheses.

Source of material	Number of ray florets	Number of disc florets	Total florets	Fruit length in mm.	Authority
var. *typica*					
Gray's Manual	(7–10)[a]	about 15[a]	.....	.....	Friesner (1933)
Range	.....	.....	.....	(2.2–3.5)[a]	Fernald (1935)
Massachusetts	11.5 (7–15)	14.5 (11–20)	26 (20–33)	2.9 (2.0–3.6)	Goodwin (1937c)
Massachusetts[b]	11.3 ± 2.6 (7–17)	15.0 ± 3.8 (9–25)	26.1 ± 5.6 (16–41)	2.92 ± 0.31 (2.3–3.7)	Goodwin & Cahill
var. *mexicana*					
Maryland[b]	8.3 ± 1.2 (7–10)	9.8 ± 1.7 (7–12)	18.1 ± 2.0 (14–21)	2.48 ± 0.50 (2.2–3.2)	Goodwin & Cahill
Florida	(8–11)	(8–15)	.....	.....	Buswell (1942)
Florida[b]	7.8 ± 1.4 (5–11)	8.2 ± 1.7 (6–11)	15.7 ± 1.4 (13–22)	2.26 ± 0.20 (1.7–2.7)	Goodwin & Cahill

[a] Figures intended to be representative of var. *typica*. Friesner's figures for the number of ray florets were probably taken from Gray's New Manual of Botany, 7th ed., 1908.

[b] Plants grown in the greenhouse at Rochester, New York.

TABLE 2. *Total number of florets per head in two strains of S. sempervirens and their F_1 and F_2 progeny.* Two heads were counted per plant and the values averaged.

Cross	12–13	14–15	16–17	18–19	20–21	22–23	24–25	26–27	28–29	30–31	32–33	34–35	36–37	38–39	40–41	No. of plants	Aver. No. of florets	σ
Mass.				2	2	3	2	5	1	0	2	1			1	19	26.1	± 2.2
Fla.	1	3	5	1												10	15.7	± 0.9
F_1		1			5	16	15	11	2							50	27.0	± 2.4
F_2		1	1	10	9	19	15	11	1	2	1			1		71	23.2	± 3.7

TABLE 3. *Fruit length, exclusive of pappus, in mm. in two strains of S. sempervirens and their F_1 and F_2 progeny.* Ten fruits were measured per plant and the values averaged.

Cross	2.05	2.15	2.25	2.35	2.45	2.55	2.65	2.75	2.85	2.95	3.05	3.15	3.25	3.35	3.45	No. of plants	Average length	σ
Mass.						1	3	3	2	2	4	1	1		1	18	2.92	± 0.25
Fla.		3	5		2											10	2.26	± 0.10
F_1					1	1	6	6	8	8	6	2	1			39	2.84	± 0.18
F_2	1	6	1	6	6	6	15	7	7	4		2				61	2.60	± 0.25

Passing now to a consideration of the species *S. sempervirens* itself, crosses have been readily obtained between the northern subsp. *typica* from Massachusetts and samples of the southern subsp. *mexicana* from Maryland and Florida. These two groups appear to differ in a number of characters, some of which, such as growth-rate, length of stem and amount of anthocyanin in the leaves, are rather unfavorable for study. Two morphological characters in the inflorescence, however, the number of florets per head and the length of the mature fruit, lend themselves to analysis. The nature of the differences are indicated in table 1. It may be noted that the Maryland material of *mexicana* is somewhat less different from *typica* than the Florida material, suggesting some genic interchange in the zone of overlap between the two subspecies.

TABLE 4. *Correlations between pairs of characters in F_1 and F_2 populations derived from crosses between Massachusetts and Florida strains of S. sempervirens, with an index which is equal to the number of genes acting on both characters plus a function of the number of linked gene pairs (one gene of each pair affecting one character, one the other).*

Character pair	Correlation in F_1	Correlation in F_2	Common gene index
Number of florets; seed length	+0.056	+0.178	0.5
Number of florets; date of bud initiation	−0.119	−0.476	2.1
Number of florets; number of days from bud initiation to anthesis	+0.043	+0.008	0.0
Seed length; date of bud initiation	−0.002	−0.045	0.3
Seed length; number of days from bud initiation to anthesis	−0.128	−0.469	1.4

The results of crosses between Massachusetts (Mass.) and Florida (Fla.) strains are given in tables 2 and 3.[2] From these data it has been estimated that differences in total floret-number and in fruit-length are each controlled by at least two genes, the exact value for n being 1.7 in each case. Apparently there is a minimum of four differentiating genes, since the computed common gene index (see table 4) indicates that there are no genes in common between these morphological characters.

A special study has been made of the inheritance of flowering time in the *sempervirens* complex. In its natural habitat this species flowers progressively later as one passes from north to south along the Atlantic seaboard. When plants from different portions of the range are grown at the same latitude under similar conditions, these plants still flower at different times, those from the north blooming earlier than those from the south. This has been interpreted as evidence for the existence within the species of a cline

[2] The flowering behavior of these same populations has previously been studied (Goodwin 1944). The author is indebted to Miss Ruth Cahill for her assistance in collecting material and the data presented in these tables.

or graded series of strains genetically distinguished from one another by their physiological requirements for floral initiation (Goodwin 1941). As a matter of fact, it has been demonstrated that the controlling environmental factor in floral initiation in this species is the length of the photoperiod (Allard & Garner 1940; Goodwin 1944). In the north, the species is able to initiate floral primordia in a relatively long day and short night, whereas in the southerly portions of the range, shorter days and longer nights are required. However, the flowering-time problem is further complicated by variations in the rate at which the buds develop, once they have become initiated.

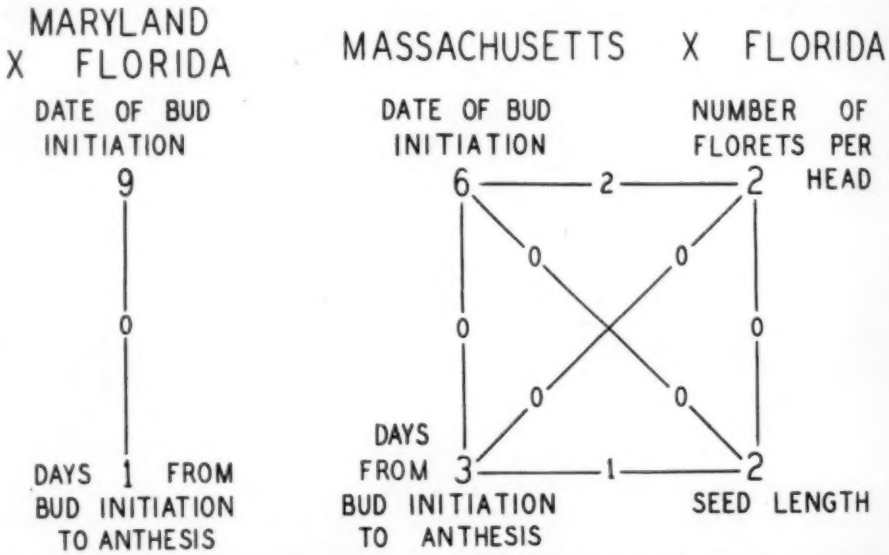

FIG. 1. Characters differentiating three strains of *S. sempervirens*, estimated minimal numbers of gene differences determining each character difference (larger digits), and maximal numbers of genes acting on both members of each character pair (digits on lines connecting the characters).

Crosses have been made between Massachusetts and Florida, and Maryland and Florida strains. From an analysis of the flowering behavior of the P_1, F_1, and F_2 generations derived from these crosses, estimates have been made of the numbers of genes differentiating these strains with respect to the date of floral initiation and the number of days elapsing between floral initiation and anthesis (Goodwin 1944). A minimum of nine or ten flowering-time genes appears to be involved. These estimates are presented in figure 1, together with those for the morphological characters in the Massachusetts × Florida cross. The maximum numbers of genes which might be held in common between these morphological and physiological characters (data from table 4 and Goodwin 1944, table 5) are also shown.

Table 5 gives a summary of the minimum numbers of genes estimated to be differentiating the various strains which have thus far been studied. A distinction has been drawn between morphological characters, which have been useful to the systematist, and physiological characters, which have been of little practical value. It should be pointed out that no assessment of physiological genes has been made in the *rugosa* × *sempervirens* cross. There are doubtless quite a number in operation (see Goodwin 1937b, 1937d).

The large number of morphological genes differentiating the two species is in marked contrast to the small number differentiating the two subspecies. These results are in agreement with those of other investigators such as Honing (1923) and Baur (1932) who have found that distinct species which are sufficiently closely related to yield fertile hybrids are differentiated by many genes. Fabergé (1943) in a recent analysis of the alpine poppies finds the genetic differences between specific categories to be multifactorial; the

TABLE 5. *Estimates of the minimum numbers of differentiating genes in Solidago crosses.*

Cross	Morphological characters	Physiological characters	Total
rugosa var. *typica* × *sempervirens* var. *typica*	21	0	21
sempervirens var. *typica* (Mass.) × *sempervirens* var. *mexicana* (Fla.)	4	9	10
sempervirens var. *mexicana* (Md.) × *sempervirens* var. *mexicana* (Fla.)	0	10	10

subspecific categories, mostly or entirely monogenic. Between species he states "that there are many other genic differences giving rise to less clear-cut phenotypic characters, which have not been recorded"; but he also expresses the opinion that in this group the taxonomists have drawn their specific distinctions too fine.

Detailed comparative studies of strains within natural groups of organisms, such as those reported by Turesson (1930), Evans (1939), Clausen, Keck and Hiesey (1940), Dobzhansky and Epling (1944), Olmsted (1944) and Goodwin (1944), bring to light numerous physiological differences. These differences may be controlled by rather large numbers of genes, as indicated by the *Solidago* studies reported in this paper.

It seems unlikely that estimates of the total numbers of genes differentiating groups of organisms are going to be of much use to systematists in the immediate future. Key characters will undoubtedly continue to be selected chiefly on the basis of practical considerations, and morphological characters will continue to be favored over physiological, as taxonomic criteria. Furthermore, there are many other variables, such as differences in the quality and

magnitude of the phenotypic effects of genes, which may also decrease the taxonomic value of numerical estimates.

In spite of these facts, studies of the type reported here represent contributions toward our understanding of the genetic complexity responsible for specific and subspecific differentiation in groups of organisms. However little value they may have for the systematist, these studies should be of significance to the student interested in the mechanics of speciation.

SUMMARY

Interspecific and intraspecific crosses in *Solidago* have been made between various strains. From analyses of the F_1 and F_2 populations, estimates have been made of the minimal numbers of genes differentiating these strains.

Taxonomic distinctions in this genus have been based upon morphological criteria. The number of genes involved in the control of some of the morphological differences in an interspecific cross has been estimated to be at least 21; in an intraspecific cross, between strains which have been considered subspecifically distinct, at least four.

For practical reasons the systematist has taken little cognizance of physiological behavior in delimiting taxonomic categories. Yet in the two intraspecific crosses studied, at least nine or ten genes appear to be involved in differentiating the parental strains with respect to flowering time. In one case, the strains were morphologically dissimilar and subspecifically distinct; in the other case, morphological differences were inadequate to warrant a taxonomic separation.

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THE VALIDITY OF THE ALGAL GENUS THAMNIASTRUM[1]

CLARENCE E. TAFT

The genus *Thamniastrum* described from Massachusetts by Reinsch (1888) has been accepted by many as a valid genus. The failure of its rediscovery has led others, Collins (1909), Printz (1927) and Smith (1933) to question its validity. Although the failure to rediscover an organism over a period of fifty years or more does not necessarily invalidate it, it does invite questions as to its legitimacy.

In this instance the writer believes that *Thamniastrum* is not a valid genus, and that Reinsch saw and figured the central, branching stalk system

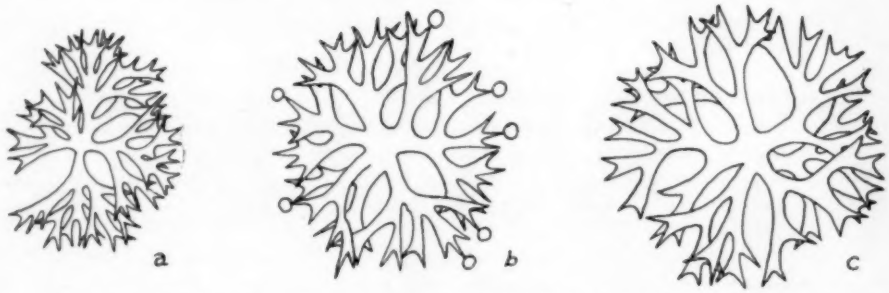

FIG. 1. *a*, The figure of *Thamniastrum* as published by Reinsch in 1888. *b*, The stalk system of *Gomphosphaeria lacustris* with a few cells attached. *c*, The stalk system of *Gomphosphaeria lacustris*.

of a colony of the blue green alga *Gomphosphaeria*. Material collected by the writer in Lake 16, Section 16, Presque Isle County, Michigan, during the summer of 1936, appears to support this contention. Collections from this lake contained numerous structures which were readily identified on the basis of shape as *Thamniastrum*. The color of the "cells" was a very pale green or blue green with transmitted yellow light. Although no cell contents could be recognized, camera lucida drawings were made and the identification assumed as no other alga had this peculiar organization. In the same collection, however, there were numerous colonies of *Gomphosphaeria lacustris*. An examination of these showed that in many instances the outer, more watery gelatinous envelope of the colony had disintegrated, allowing the cells to break away. This disintegration which was probably due to the exceptionally high temperature of the lake water had, in some instances continued until only a very few cells remained attached to the radiately branched, central

[1] Papers from the Department of Botany, The Ohio State University, No. 476.

mass, or stalk system. In every case, the central stalk system was identical in appearance with the previously identified *Thamniastrum*.

The similarities which exist between the figures of *Thamniastrum* and the stalk system of *Gomphosphaeria* are evident in the accompanying figures. Fig. 1a is that of *Thamniastrum* as published by Reinsch in 1888. Fig. 1b is the stalk system of *Gomphosphaeria* from which the outer, watery colonial envelope, as well as most of the cells, has disappeared. Fig. 1c is the central stalk system of *Gomphosphaeria* from which all cells and the outer envelope have disappeared.

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THOMAS JEFFERSON

HIS INTEREST IN PLANT LIFE AS REVEALED IN HIS WRITINGS—II*

EDMUND H. FULLING

BOTANY

Jefferson's relation to botany, distinguished as a pure science from the more utilitarian practices of agriculture and the more aesthetic art of gardening, was primarily that of patron and sponsor rather than that of devotee by either profession or avocation. He took occasions to express himself, however, as we shall note, with regard to certain biological principles, and in his famous *Notes on the state of Virginia* he left a compendium of scientific observations that might be the envy of any investigator. More important, however, were his sponsorship of a famous expedition and his advocacy of botanical and agricultural studies in university curricula. These aspects of his activities will now occupy our attention, and in conclusion we shall note the genus of plants named after him in recognition of his erudition in matters of natural history.

TAXONOMY AND NOMENCLATURE

As we have already observed in considerable detail, Jefferson's interest in American agriculture was very much stimulated during his residence in France by the farming practices of the peasants there and in Italy; and a little later we shall give attention to his concern for exploration, also stimulated by a perspective gained abroad. It is not surprising, therefore, that on one occasion when writing from Paris to the President of Harvard, he should have exclaimed:

"What a field have we at our doors to signalize ourselves in! The Botany of America is far from being exhausted."[1]

He had in mind, of course, the natural flora of North America, the study of which had scarcely begun. Taxonomic concepts and nomenclature at that time were in a state of great change, and the influence of Linnaeus was just beginning to sift into the thoughts of American naturalists. Only 36 years had elapsed since the publication of Linnaeus' *Species Plantarum*, and comparisons were still being made by those who knew anything about the matter, not merely from a historical standpoint but respecting their debatable merits, between his artificial scheme of arrangement and other systems of classifica-

* Part I of this series appeared in Bull. Torrey Club **71**: 563–598.

[1] Letter to Dr. Willard, March 24, 1789 (13, VII, *325*).

tion, especially the natural one of Jussieu. It is significant, therefore, that Jefferson was acquainted with the unsettled state of such abstract topics as were involved in this transition, and that he should have been called upon, several years after his retirement from the Presidency, for an opinion in the matter:

"The opinion which . . . you are pleased to ask of me, on the comparative merits of the different methods of classification adopted by different writers on Natural History, is one which I could not have given satisfactorily, even at the earlier period at which the subject was more familiar; still less, after a life of continued occupation in civil concerns has so much withdrawn me from studies of that kind . . . Nature has, in truth, produced units only through all her works. Classes, orders, genera, species, are not of her work. Her creation is of individuals . . . No two animals are exactly alike; no two plants, nor even two leaves or blades of grass . . . This infinitude of units or individuals being far beyond the capacity of our memory, we are obliged, in aid of that, to distribute them into masses, throwing into each of these all the individuals which have a certain degree of resemblance; to subdivide these again into smaller groups, according to certain points of dissimilitude observable in them, and so on until we have formed what we call a system of classes, orders, genera and species. In doing this, we fix arbitrarily on such characteristic resemblances and differences as seem to us most prominent and invariable in the several subjects, and most likely to take a strong hold in our memories. Thus Ray formed one classification on such lines of division as struck him most favorably; Klein adopted another; Brisson a third, and other naturalists other designations, till Linnaeus appeared. Fortunately for science, he conceived in the three kingdoms of nature, modes of classification which obtained the approbation of the learned of all nations. His system was accordingly adopted by all, and united all in a general language. It offered the three great desiderata: First, of aiding the memory to retain a knowledge of the productions of nature. Secondly, of rallying all to the same names for the same objects, so that they could communicate understandingly on them. And thirdly, of enabling them, when a subject was first presented, to trace it by its character up to the conventional name by which it was agreed to be called. This classification was indeed liable to the imperfection of bringing into the same group individuals which, though resembling in the characteristics adopted by the author for his classification, yet have strong marks of dissimilitude in other respects. But to this objection every mode of classification must be liable, because the plan of creation is inscrutable to our limited faculties. Nature has not arranged her productions on a single and direct line. They branch at every step, and in every direction, and he who attempts to reduce them into departments, is left to do it by the lines of his own fancy. The objection of bringing together what are disparata in nature, lies against the classification of Blumenbach and of Cuvier, as well as that of Linnaeus, and must forever lie against all. Perhaps not in equal degree; on this I do not pronounce. But neither is this so important a consideration as that of uniting all nations under one language in Natural History. This had been happily effected by Linnaeus, and can scarcely be hoped for a second time. Nothing indeed is so desperate as to make all mankind agree in giving up a language they possess, for one which they have to learn. The attempt leads di-

rectly to the confusion of the tongues of Babel. Disciples of Linnaeus, of Blumenbach, and of Cuvier, exclusively possessing their own nomenclatures, can no longer communicate intelligibly with one another. However much, therefore, we are indebted to both these naturalists, and to Cuvier especially, for the valuable additions they have made to the sciences of nature, I cannot say they have rendered her a service in this attempt to innovate in the settled nomenclature of her productions; on the contrary, I think it will be a check on the progress of science, greater or less, in proportion as their schemes shall more or less prevail. They would have rendered greater service by holding fast to the system on which we had once all agreed, and by inserting into that such new genera, orders, or even classes, as new discoveries shall call for. Their systems, too, and especially that of Blumenbach, are liable to the objection of giving too much into the province of anatomy. It may be said, indeed, that anatomy is a part of natural history. In the broad sense of the word, it certainly is. In that sense, however, it would comprehend all the natural sciences, every created thing being a subject of natural history in extenso. But in the subdivisions of general science, as has been observed in the particular one of natural history, it has been necessary to draw arbitrary lines, in order to accommodate our limited views. According to these, as soon as the structure of any natural production is destroyed by art, it ceases to be a subject of natural history, and enters into the domain ascribed to chemistry, to pharmacy, to anatomy, etc. Linnaeus' method was liable to this objection so far as it required the aid of anatomical dissection . . . It would certainly be better to adopt as much as possible such exterior and visible characters as every traveller is competent to observe, to ascertain and to relate. But with this objection, lying but in a small degree, Linnaeus' method was received, understood, and conventionally settled among the learned, and was even getting into common use. To disturb it then was unfortunate. The new system attempted in botany, by Jussieu, in mineralogy by Haüy, are subjects of the same regret, and so also the no-system of Buffon, the great advocate of individualism in opposition to classification. He would carry us back to the days and to the confusion of Aristotle and Pliny, give up the improvements of twenty centuries, and co-operate with the neologists in rendering the science of one generation useless to the next by perpetual changes of its language. In botany, Wildenow and Persoon have incorporated into Linnaeus the new discovered plants."[2]

In the foregoing opinion and in his preferring to retain the unnatural system of Linnaeus despite its recognised shortcomings, we find not only an indication of Jefferson's antipathy to changes in existing methods of scientific nomenclature and terminology but also that unusual interest which he so constantly exhibited in matters wholly foreign to the man not primarily concerned in their pursuit. More remarkable, however, as revealed in that opinion, was Jefferson's grasp of certain abstruse principles underlying classification, of the concept that Nature makes only individuals and that man, merely for his own convenience, attempts to recognize finite groups among them. And who but Jefferson, except it be his contemporary Benja-

[2] Letter to Dr. John Manners, February 22, 1814 (13, XIV, *97*).

min Franklin, would appreciate at that time the role of Linnaeus, or even know that he existed, and much less, know that there were such other scholars as Jussieu, Willdenow, Buffon, Persoon, Ray, Klein, Brisson, Blumenbach, Cuvier, and Haüy. If one must find some ground in that letter for criticism it would probably be that Jefferson apparently was unacquainted or at least not concerned with the question of "natural" vs. "artificial" classification, and did not foresee that phylogeny would eventually provide the universally accepted basis.

PLANT PHYSIOLOGY

In the realm of plant physiology, too, Jefferson was reluctant to accept new ideas as soon as they were proposed, and in this respect he failed to reveal that foresighted recognition of advancement and truth which characterized so much of his other thought. In 1772 Priestley had been the first to note that green plants produce oxygen, and two years later Ingen-Housz, in forsaking certain previous ideas, claimed that sunlight had much to do with this process. Jefferson, however, though he is to be admired merely for knowing that the assimilatory and respiratory functions of green plants were being investigated, wanted further proof of this function before relinquishing earlier notions, and in writing from Paris to the President of William and Mary College, at Williamsburg, he commented:

"You know also that Dr. Ingenhouss had discovered, as he supposed, that vegetation might be promoted by occasioning streams of the electrical fluid to pass through a plant, and that other physicians had received and confirmed this theory. He now, however, retracts it, and finds by more decisive experiments, that the electrical fluid can neither retard nor forward vegetation. Uncorrected still of the rage of drawing general conclusions from partial and equivocal observations, he hazards the opinion that *light* promotes vegetation. I have heretofore supposed from observation, that light affects the color of living bodies, whether vegetable or animal; but that either the one or the other receives nutriment from that fluid must be permitted to be doubted of, till better confirmed by observation."[3]

Jefferson believed that "it is by the assistance of heat and moisture, that vegetables are elaborated from the elements of earth, air, water, and fire,"[4] a thought which, as Dr. Brown has observed, might have been taken from Aristotle or Pliny. And the role of legumes in restoring fertility to his depleted soil at Monticello was no better understood; Jefferson thought they served primarily in preserving a suitable physical condition in the soil.

Jefferson's false notions in these three and any other aspects of plant physiology which he may have held were, for the most part, reflections of what was known at the time concerning the functions of plants. Had photo-

[3] Letter to Bishop James Madison, July 19, 1788 (13, VII, *73*).
[4] (13, II, *62*).

synthesis, nitrification, and the role of chemical elements in the life of plants been better understood, it is safe to assume that Jefferson would have been familiar with at least the fundamentals of these processes as we now understand them.

"NOTES ON THE STATE OF VIRGINIA"

Jefferson's principal literary work, apart from his political writings, was his *Notes on the state of Virginia*. This contribution, covering 261 pages of his "Writings" (13), was an account of many topics written in response to requests from the Marquis de Barbe-Marbois, Secretary of the French Legation in Philadelphia, for information of many kinds desired by the latter's government. It was begun in 1781 and privately printed in Paris in 1784–1785 during Jefferson's residence there, but dated 1782. That original edition of 200 copies was followed at various times by French, English, German and numerous American editions. Virginia at that time, it must be remembered, was larger than at present, including what today are the States of Virginia, West Virginia, and Kentucky. Jefferson divided his notes into queries, and under Query VI, entitled "A Notice of the Mines and other Subterranean riches; its trees, plants, fruits, etc.," he began his botanical discussion by commenting that:

"A complete catalogue of the trees, plants, fruits, &, is probably not desired. I will sketch out those which would principally attract notice, as being first, Medicinal; second, Esculent; third, ornamental; or four, useful for fabrication; adding the Linnaean system to the popular names, as the latter might not convey precise information to a foreigner. I shall confine myself, too, to native plants."[5]

Jefferson then listed 129 plants in the four categories, with popular names and Linnaean equivalents for nearly every one. In connection with one of the half-dozen or so for which he did not give Latin names he added the following explanation and thereby not only again revealed his appreciation of nomenclature and his acquaintance with recognized authorities of his day, but, in the opinion of the late Professor True (27), actually started the nomenclatural history of the tree concerned:

"Paccan, or Illinois nut. Not described by Linnaeus, Millar, or Clayton. Were I to venture to describe this, speaking of the fruit from memory, and of the leaf from plants of two years' growth, I should specify it as *Juglans alba, foliolis lanceolatis, acuminatis, serratis, tomentosis, fructu minore, ovato, compresso, vix insculpto, dulci, putamine tenerrimo.* It grows on the Illinois, Wabash, Ohio and Mississippi. It is spoken of by Don Ulloa under the name of Pacanos, in his Noticias Americanas."[6]

A year after the appearance of this account in 1784, Humphrey Marshall published a description of the same tree in his *Arbustrum Americanum*, and

[5] (13, II, *49*).
[6] (13, II, *51*).

there bestowed upon it the name *Juglans pecan*. Marshall's description, however, in Professor True's judgment, failed to distinguish the pecan from the pig-nut hickory, and "the name proposed by him is left so nearly nude that its title to priority is doubtful. The earlier, clean-cut, adequate diagnosis by Jefferson, can only on bibliographic technicality fail to secure for him the credit of being the first scientific sponsor for the pecan" (27). However valid or otherwise the claims for Jeffersonian priority in this matter may be in the minds of nomenclaturists and taxonomists today, the interesting fact remains that Jefferson was sufficiently interested in the tree and versed in a botanical approach to it that he recognized it as unnamed by the authorities of the time—Linnaeus, Miller, Clayton—and therefore endeavored to bring it within the fold of scientific recognition. For 25 years the tree had been known to other American naturalists, including John Bartram, but none had ventured to name it. As we have already noted, Jefferson attempted to introduce its cultivation into France, and in his correspondence concerning the tree, he recognized Marshall's name as official but spelled it *Juglans Paccan*.[7]

Jefferson realized that the list of plants in his *Notes* did not by any means include all the plants of Virginia, and he therefore referred his readers for further information to "Dr. Clayton's" *Flora Virginiana*, published by Gronovius at Leyden in 1762. Later, in an appendix to his *Notes*, he was induced to add to that list what we today know as Jimson weed by way of corruption of its original name of Jamestown weed:

> "There is a plant, or a weed, called the Jamestown weed, of a very singular quality. The late Dr. Bond informed me, that he had under his care a patient, a young girl, who had put the seeds of this plant into her eye, which dilated the pupil to such a degree, that she could see in the dark, but in the light was almost blind. The effect that the leaves had when eaten by a ship's crew that arrived at Jamestown, are well known."[8]

In a footnote, Jefferson then referred to a mention which he found of an instance of temporary imbecility caused by these seeds. More interesting, however, in connection with this plant, is Jefferson's reference to it in one of his letters. His correspondent had sent him a supply of capsicum which he hoped to find hardy enough for growth in the climate of his neighborhood, species previously tried having been too tender. His correspondent had sent him also some "galvance"[9] which appeared to be different from what was generally cultivated under that name. In view of his having so many grandchildren and others about him, however, who might have been endangered by the poisonous plant, Jefferson regarded the risk as overbalancing his curiosity to experiment with it, and he impliedly made no attempt to grow it.

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[7] Letter to Francis Hopkinson, December 23, 1786 (13, VI, *20*).

[8] (13, II, *267*).

[9] A variety of edible pea.

But he seems to have recognised virtues in its lethal nature, and to have advocated euthanasia, for he wrote elsewhere, in referring to deadly drugs:

"The most elegant thing of that kind known is a preparation of the Jamestown weed, Datura-Stramonium, invented by the French in the time of Robespierre. Every man of firmness carried it constantly in his pocket to anticipate the guillotine. It brings on the sleep of death as quietly as fatigue does the ordinary sleep, without the least struggle or motion. Condorcet, who had recourse to it, was found lifeless on his bed a few minutes after his landlady had left him there, and even the slipper which she had observed half suspended on his foot, was not shaken off. It seems far preferable to the Venesection of the Romans, the Hemlock of the Greeks, and the Opium of the Turks. I have never been able to learn what the preparation is, other than a strong concentration of its lethiferous principle. Could such a medicament be restrained to self-administration, it ought not to be kept secret. There are ills in life as desparate as intolerable, to which it would be a rational relief, *e.g.*, the inveterate cancer. As a relief from tyranny indeed, for which the Romans recurred to it in the times of the emperors, it has been a wonder to me that they did not consider a poignard in the breast of the tyrant as a better remedy."[10]

Our interest in Jefferson's *Notes* lies not only in his enumeration of species and in his original observations on the pecan, but also in his appreciation of the value of scientific names. Undoubtedly, to the average man of his time, as to the layman of today, unconcerned with universality of knowledge, technical names constituted a superfluity. Jefferson, however, internationally minded as he was in scientific matters, wanted the "foreigner," as he expressed it, to know which plants he was writing about. He undoubtedly always had in mind the French savants, for, as we have already indicated, it was especially for them that his *Notes* were assembled. Similar understanding on his part is revealed when he says, in referring to tobacco, maize, round potatoes, pumpkins, cymlings, and squashes found by the English settlers in Virginia:

"it is not said whether of spontaneous growth, or by cultivation only. Most probably they were natives of more southern climates, and handed along the continent from one nation to another of the savages."[11]

His recognition of introduced plants is then expanded in a manner which throws much light on the kinds of crops being raised in Virginia:

"Besides these plants, which are native, our Farms produce wheat, rye, barley, oats, buck-wheat, broom corn, and Indian corn. The climate suits rice well enough, wherever the lands do. Tobacco, hemp, flax, and cotton, are staple commodities. The silk-worm is a native, and the mulberry, proper for its food, grows kindly. Indigo yields two cuttings.

"We cultivate, also, potatoes, both the long and the round, turnips, carrots, parsnips, pumpkins, and ground nuts (*Arachis*). Our grasses are lucerne,

[10] Letters to Dr. Samuel Brown, July 14, 1813 (13, XIII, *310*).

[11] (13, II, *53*).

St. Foin, burnet, ray(?), and orchard grass; red, white, and yellow clover; greensward, blue grass, and crab grass.

"The gardens yield musk-melons, water-melons, tomatoes, okra, pomegranates, figs, and the esculent plants of Europe.

"The orchards produce apples, pears, cherries, quinces, peaches, nectarines, apricots, almonds, and plums."[12]

It is from a letter written many years later, however, that we learn how well informed Jefferson was on purely academic aspects of introduced plants. At that time he had occasion to acknowledge receipt of a copy of a "General Geography" from the author of the volume, and after expressing thanks for the tome, he indulged in a little book-reviewing:

"In passing my eye rapidly over parts of the book, I was struck with two passages, on which I will make observations, not doubting your wish, in any future edition, to render the work as accurate as you can. In page 186 you say the potato is a native of the United States. I presume you speak of the Irish potato. I have inquired much into the question, and think I can assure you that plant is not a native of North America. Zimmerman, in his "Geographical Zoology," says it is a native of Guiana; and Clavigero, that the Mexicans got it from South America, its native country. The most probable account I have been able to collect is, that a vessel of Sir Walter Raleigh's, returning from Guiana, put into the west of Ireland in distress, having on board some potatoes which they called earth-apples. That the season of the year, and circumstance of their being already sprouted, induced them to give them all out there, and they were no more heard or thought of, till they had been spread considerably into that island, whence they were carried over into England, and therefore called the Irish potato. From England they came to the United States, bringing their name with them."[13]

Jefferson gave considerable thought to climatological conditions in his *Notes* and was much concerned with their bearing upon plant life. At one point, for instance, he referred to the reports of travelers that the climate west of the Alleghany Mountains was warmer than east of them along the same latitude, and observed that:

"Their testimony is strengthened by the vegetables and animals which subsist and multiply there naturally, and do not on the sea-coast. Thus Catalpas grow spontaneously on the Mississippi, as far as the latitude 37°, and reeds as far as 38°."[14]

Continuing his climatological observations, he then informed his French readers that:

"White frosts are frequent when the thermometer is at 47°, have killed young plants of Indian corn at 48° . . . I have known frosts so severe as to kill the hickory trees round about Monticello, and yet not injure the tender fruit blossoms then in bloom on the top and higher parts of the mountain;

[12] (13, II, *54*).

[13] Letter to Horatio G. Spafford, May 14, 1809 (13, XII, *278*).

[14] (13, II, *106*).

and in the course of forty years, during which it had been settled, there have been but two instances of a general loss of fruit on it; while in the circumjacent country, the fruit has escaped but twice in the last seven years. The plants of tobacco, which grow from the roots of those which have been cut off in the summer, are frequently green here at Christmas."[15]

"A more satisfactory estimate of our climate to some, may perhaps be formed, by noting the plants which grow here, subject, however, to be killed by our severest colds. These are the fig, pomegranate, artichoke, and European walnut. In mild winters, lettuce and endive require no shelter; but, generally, they need a slight covering. I do not know that the want of long moss, reed, myrtle, swamp laurel, holly, and cypress, in the upper country proceeds from a greater degree of cold, nor that they were ever killed with any degree of cold in the lower country. The aloe lived in Williamsburg, in the open air, through the severe winter of 1779, 1780."[16]

Elsewhere in his *Notes*, where they are concerned with the honey bee, Jefferson concluded that the Laplanders did not have honey, for it was reported that they ate pine bark, prepared in a certain way, instead of articles sweetened with sugar.[17]

Lastly, in considering the plant-life aspects of his *Notes*, we can not afford to overlook the statistics which Jefferson provided on the annual export of plant products from Virginia before the war between England and France:[18]

Tobacco	55,000 hhds. of 1,000 lbs. each	$1,650,000	30d per hhd.
Wheat	800,000 bu.	666,666	5–6d per bu.
Maize	600,000 bu.	200,000	1/3d per bu.
Tar, pitch, turpentine	30,000 bbl.	40,000	1⅓d per bbl.
Flax seed, hemp, cotton	4,000 bbl.	8,000	
Peas	5,000 bu.	3,333	2/3d per bu.

And if we turn to Jefferson for comparable figures concerning all the States, he accommodates us in one of his letters to La Fayette with estimates of such exports and their values in Louis:[19]

	To Europe Louis	To West Indies Louis
Wheat, 2,210,000 bu.	331,000	
Maize	30,000	61,000
Rice, 130,000 bbl.	189,350	70,650
Indigo	51,700	
Tobacco, 87,000 hhds.	1,306,000	
Flax seed	79,500	
Hemp	21,000	
Hops	216,500	

[15] (13, II, *113*).
[16] (13, II, *114*).
[17] (13, II, *104*).
[18] (13, II, *231*).
[19] Letter to La Fayette, July 17, 1786 (19, *97*).

In connection with the foregoing observations in his *Notes* it is fitting to observe what Jefferson penned in his account of a visit to Saratoga, Stillwater, Bennington, and Forts William, Henry, George, Ticonderoga, and Crown Point, all famous in the revolutionary misfortunes of General Burgoyne:

"We were more pleased, however, with the botanical objects which continually presented themselves. Those either unknown or rare in Virginia, were the sugar maple in vast abundance. The silver fir, white pine, pitch pine, spruce pine, a shrub with decumbent stems, which they call juniper, an azalea, very different from the nudiflora, with very large clusters of flowers, more thickly set on the branches, of a deeper red, and high pink-fragrance. It is the richest shrub I have seen. The honey-suckle of the gardens growing wild on the banks of Lake George, the paper-birch, an aspen with a velvet leaf, a shrub-willow with downy catkins, a wild gooseberry, the wild cherry with single fruit, (not the bunch cherry) strawberries in abundance."[20]

Professor True has pointed out, on the authority of someone else, that the azalea so enthusiastically referred to in this letter probably was *A. canescens*, first formally described twelve years later in 1803 by Richard in Michaux' "Flora," and that "had Jefferson taken the trouble to give his observations the form of conventional descriptions, it is quite likely that his discoveries would have added several plants then new to science" (27).

LEWIS AND CLARK EXPEDITION

The culmination of Jefferson's interest in scientific pursuits and the master stroke in his patronage of such enterprises, was his conception and successful sponsorship of the justly famous Lewis and Clark Expedition. History generally accords the honors of exploration—and rightly so—to those who endure the privations and hardships of traversing previously unexplored lands, to those who risk their lives, leave the comforts of home and display the genius for organization, supervision and initiative so necessary in such undertakings. The sponsoring scientific societies or patronizing millionaires are generally known only to a few and very often do not merit greater recognition. For the Lewis and Clark Expedition, however, history makes an exception, and in even the most elementary treatise on early American affairs one finds this expedition closely associated not only with the administration of Thomas Jefferson as President of the United States but also with the man himself. Other phases of his scientific interests discussed in this paper are not matters of common historical knowledge; the Lewis and Clark Expedition, however, is at least related to every school-boy in America; it is fitting, therefore, that we include in this chapter of Jefferson's relation to pure botany an account of this project which was his greatest contribution to science.

[20] Letter to Thomas Mann Randolph, June 5, 1791 (13, VIII, *204*).

As is true of most other elaborate and productive enterprises, this one, too, was not conceived and executed all at once. Jefferson had long been interested in the vast unexplored territory which lay west of the Mississippi, and this concern was nurtured during his residence in France, where, we are told, he purchased every available book relating to the exploration, geography, and history of North America. While there, serving as American representative after Franklin, he became acquainted with one John Ledyard, a Connecticut explorer who had been a companion of Captain Cook through Behring Straits and on his last fateful visit to the Sandwich Islands. Ledyard's adventurous nature was seeking new worlds to conquer, and Jefferson prevailed upon him to return home via Siberia, Alaska, and the west coast of America, and to explore the great unknown country of the American Northwest on his way eastward. Ledyard undertook this hazardous route and proceeded nearly to Kamchatka, where further progress was forbidden by the Empress of Russia. Thus, as Jefferson wrote, "failed the first attempt to explore the western part of our northern continent."[21]

In 1789 Jefferson returned to America, and in Washington's cabinet he became the first American Secretary of State. While serving in that capacity he proposed that an exploring party be sent into the Northwest. Nothing, apparently, resulted from the suggestion, for in 1792 we find him again reviving the project, this time before the American Philosophical Society. He wanted the Society to raise funds for engaging a competent scientist to explore the northwestern territory by ascending the Missouri River, crossing the mountains and descending to the Pacific. The Society, apparently, was favorably impressed by his appeal and decided to sponsor the project. In seeking for someone to conduct such an expedition, it accepted the proffered services of André Michaux, the skilled botanist and experienced explorer who at the time was in America in the services of the French government. The expedition was financed by subscriptions and Jefferson apparently contributed £50, for in his Account Book, under date of April 28, 1793, we find the note "pd. ¼ of my subscription for Michaud's [sic] journey to Pacific sea 12.5." In Jefferson's instructions to Michaux regarding the latter's notes to be made, we find the following very interesting detail:

"The method of preserving your observations is left to yourself, according to the means which shall be in your power. It is only suggested that the noting them on the skin might be best for such as may be the most important, and that further details may be committed to the bark of the paper-birch, a substance which may not excite suspicions among the Indians, and little liable to injury from wet or other common accidents. By the means of the same substance you may perhaps find opportunities, from time to

[21] Letter to Paul Allen, April 13, 1813 (13, XVIII, *140*).

time, of communicating to the society information of your progress, and of the particulars you shall have noted."[22]

Michaux arranged his party and set out, but had proceeded only as far as Kentucky when he was overtaken by an order from the French Minister in Philadelphia to pursue his botanical explorations elsewhere and to abandon his proposed journey into the Northwest. "Thus," wrote Jefferson, "failed the second attempt for exploring that region"[21] and the American Philosophical Society was deprived of sponsoring what might have become one of the greatest botanical explorations in North America. This frustration did not, however, diminish Jefferson's interest in botanical exploration or in the particular accomplishments of Michaux & Son. Twenty-three years later, in the concluding sentence of a letter otherwise devoted to his retirement from the Presidency of the Philosophical Society, he suddenly takes pride in his acquisition of Michaux's writings, by stating:

"Of Michaux's work, I possess three volumes, or rather cahiers, one on Oaks, another on Beeches and Birches, and a third on Pines."[23]

A few years earlier he had written to Michaux himself:

"I have duly received your favor of Aug. 10 and, with it, your beautiful account of the pines & firs of our country, for which be pleased to accept my thanks. I sincerely wish the work may be prosecuted, & that the citizens of the U. S. may not be wanting in due encouragement to it. nothing should be spared which I could do to befriend it. accept my best wishes that you may enjoy health to continue your useful labors."[24]

Jefferson's next opportunity to promote his project did not come until his third year as President of the United States. It was in his confidential message to Congress on January 18, 1803, in connection with the renewal of the act establishing trading houses with the Indians. He wanted the provisions of that act extended to the tribes on the Missouri, and along with his appeal he resurrected his favorite scheme by recommending that an exploring party be sent to trace the Missouri River to its source, then to cross the divide and to proceed by the best water route to the Pacific. Congress approved the proposition and appropriated $5,000 for its execution. Meriwether Lewis, who had unsuccessfully applied in 1792 for leadership of the ill-fated American Philosophical Society expedition and had since then become a Captain in the Army and Secretary to Jefferson, was appointed by the latter to lead the expedition, with Lieutenant William Clark as second in command. Lewis had renewed his request to lead the party, and having won Jefferson's confidence he obtained the appointment. The success of the

[22] Instructions to Andrew Michaud for exploring the western boundary (13, XVII, *335*).

[23] Letter to John Vaughan, February 5, 1815 (13, XIV, *239*).

[24] Letter to M. Michaux, April 15, 1811 (17, *115*).

project is a tribute not only to Lewis' able leadership but as well to Jefferson's judgment in selecting him.

The preliminary details, general instructions and many other phases of the trip are beyond our interest in this account, but the concern which Jefferson displayed in those preliminaries and instructions with respect to plant life are, of course, pertinent to this study.

We find, for instance, that Jefferson sent Lewis to Dr. B. S. Barton of the Philosophical Society in Philadelphia in order that Lewis might become better acquainted with the botanical aspects of his contemplated journey. Had Michaux been able to continue as the original leader, Jefferson would not have had any occasion to be disturbed concerning botanical and allied matters. Under the circumstances, however, he was forced to admit to Dr. Barton, in emphasizing the qualifications of Lewis, that:

"It was impossible to find a character who, to a complete science in Botany, Natural History, Mineralogy and Astronomy, joined the firmness of constitution and character, prudence, habits adapted to the woods, and familiarity with the Indian manners and character, requisite for this undertaking. All the latter qualifications Captain Lewis has. Although no regular botanist, etc., he possesses a remarkable store of accurate observation on all the subjects of the three kingdoms, and will, therefore, readily single out whatever presents itself new to him in either . . . In order to draw his attention at once to the objects most desirable, I must ask the favor of you to prepare for him a note of those in the lines of botany, zoology, or of Indian history, which you think most worthy of enquiry and observation."

This concern on the part of Jefferson for Lewis' being able to make proper observations and records was not just an incidental matter, for he concluded his letter to Barton by saying:

"I make no apology for this trouble, because I know that the same wish to promote science which has induced me to bring forward this proposition, will induce you to aid in promoting it."[25]

In his instructions to Lewis for conducting the expedition, the latter was admonished to note the agricultural practices of the Indians and the plants they used as food. The observation was also made that:

"Other objects worthy of notice will be, the soil and face of the country, its growth and vegetable productions, especially those not of the United States, . . . the dates at which particular plants put forth or lose their flower or leaf. . . ."[26]

On August 31, 1803, the expedition set out from Pittsburgh. After spending three winters en route, one of them on the Pacific Coast, it returned to St. Louis on September 23, 1806, where the party disbanded. Between those dates, the 30 or so persons who constituted this intrepid band of explorers

[25] Letter to Dr. B. S. Barton, February 27, 1803 (13, X, *366*).
[26] Letter to Paul Allen, April 13, 1813 (13, XVIII, *140*).

contributed to American history what will always remain one of the greatest if not the greatest feat of exploration in North America. Its most important result was wholly political in substantiating the new nation's claim to the Pacific Northwest. Its scientific results, too, were important, though, as a rule, they have been less emphasized, since most general historical accounts are political, rather than economic, social, or scientific.

On the way to the coast a collection of plants was made and then lost when it was deposited among other things somewhere at the foot of the Rocky Mountains. On the return trip another but less extensive collection was assembled, the subsequent history of which, until it was deposited in the Philadelphia Academy of Natural Sciences, involved many hardships. The task of describing the plants collected was given by Lewis through his friend Bernard McMahon to the English botanist Frederick Pursh who published an account of them in his *Flora Americae Septentrionalis* of 1814. Three subsequent commentaries on the collection and on Pursh's work in connection with it have appeared (22, 25, 26). To delve into the details of those three papers would be to go unjustifiably beyond the intended scope of the present writing into details which belong rather to the contributions of Lewis and certain botanists than to those of Jefferson. It suffices to note here that in his treatment of the 150 specimens submitted to him, Pursh referred to 119 different plants, many of which he described as wholly new. Through later work of other botanists, 183 distinct forms have been recognized (25).

Jefferson was more concerned with disposal of the seeds gathered by Lewis and with publication of the latter's journals. From several of his letters, including one to M. de la Cepède[27] of the National Institute of Paris, we learn that Jefferson entrusted the seeds collected by Lewis to a Mr. Hamilton, wealthy owner of the famous Philadelphia gardens known as "The Woodlands," and to Mr. Bernard McMahon, a botanist and nurseryman of the same city. He appears to have approached the latter as follows:

"Captain Lewis has brought a considerable number of seeds of plants peculiar to the countries he has visited. I have recommended him to confide principal shares of them to Mr. Hamilton of the Woodlands and yourself as persons most likely to take care of them, which he will accordingly do. He will carry them on to Philadelphia himself."[28]

Two months later Jefferson expressed further concern about the seeds:

"I am in hopes I am more fortunate in the seeds I now send you than (in) the effete roots before sent. The enclosed seeds are given me by Captain Lewis for my own garden, but as I am not in a situation to do them justice and am more anxious they should be saved in any way than merely to see them in my own possession, I forward them to you who can give them their best chance. It will give you too an opportunity of committing them earlier

[27] Letter to M. de la Cepède, July 14, 1809 (13, XII, *83*).
[28] Letter to Bernard McMahon, January 6, 1807 (14, LIX, No. 67).

to the ground than those you will receive from Captain Lewis for yourself as it may yet be sometime before he is with you. perhaps you may as well say nothing of your receiving this list it might lessen the portion he will be disposed to give you; and believing myself they will be best in your hands, I wish to increase the portion deposited with you."[29]

Two days later Jefferson was induced by a change in Lewis' plans to write as follows, first to McMahon, than to Hamilton:

"Governor Lewis's journey to Philadelphia being delayed longer than was expected, and the season advancing, we have thought it best to forward to you by post the packet of seeds destined for you. they are the fruits of his journey across the continent and will I trust add some useful or agreeable varieties to what we now possess. I send a similar packet to Mr. Hamilton of the Woodlands. in making him and yourself the depositories of these public treasures, I am sure we take the best measures possible to insure them from being lost. I sent you a small packet a few days ago which he had destined for myself, but I am in too indifferent a situation to take the care of them which they merit."[30]

"it is with great pleasure that, at the request of Governor Lewis, I send you the seeds now enclosed, being a part of the Botanical fruits of his journey across the continent. I cannot but hope that some of them will be found to add useful or agreeable varieties to what we now possess. these with the descriptions of plants, which, not being in seed at the time, he could not bring, will add considerably to our Botanical possessions. he will equally add to the Natural history of our country. on the whole, the result confirms me in my first opinion that he was the fittest person in the world for such an expedition. he will be with you shortly at Philadelphia, where I have no doubt you will be so kind as to shew him those civilities which you so readily bestowed on worth. I send a similar packet to Mr. McMahon to take the chance of a double treatment in confiding these public deposits to your and his hands, I am sure I make the best possible disposition of them."[31]

Jefferson himself raised a few seedlings from Lewis' seeds, as he once informed McMahon:

"I shall be at home early in March for my permanent residence, and shall very much devote myself to my garden. I reserved very few of Governor Lewis's articles, and have growing only his salsafia, Mandane corn and a pea remarkable for its beautiful blossom and leaf. his forward bean is growing in my neighborhood."[32]

Two years later he sent to Dr. Barton, from these plants grown at Monticello, "some Ricara snap beans and Columbian salsafia brought from the western side of the continent by Captain Lewis."[33]

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[29] Letter to Bernard McMahon, March 20, 1807 (14, LIX, No. 68).
[30] Letter to Bernard McMahon, March 22, 1807 (14, LIX, No. 69).
[31] Letter to Wm. Hamilton, March 22, 1807 (14, XLII, No. 26).
[32] Letter to Bernard McMahon, July 6, 1808 (14, LIX, No. 70).
[33] Letter to Dr. Benjamin S. Barton, October 6, 1810 (14, X, No. 81).

In February of 1812 McMahon sent Jefferson specimens of *Ribes odoratissimum*, *Symphoricarpos leucocarpa*, and a yellow currant, all found by Lewis, and eight months later Jefferson replied:

"The articles received in the spring . . . have been remarkably successful. one only of the cuttings of the snowberry failed. the rest are now very flourishing and shew some of the most beautiful berries I have ever seen. the sweet scented currant, the yellow currant, the red gooseberries and Hudson strawberries are all flourishing."[34]

It is also apparent, from other letters, that Jefferson was considerably irritated by delay in publication of the botanical and other scientific findings of the expedition. This delay was occasioned by preparation of engravings, by the tragic death of Lewis in 1809 and of Dr. Barton, by the outbreak of war with England in 1812, and by insolvency of the printers. In December, 1813, Jefferson expected Lewis' daily journal to appear soon in print, and on the basis of this expectation he wrote to his European friend, the explorer Baron Alexander von Humboldt:

"These I will take care to send you with the tobacco seed you desired, if it be possible for them to escape the thousand ships of our enemies spread over the ocean. The botanical and zoological discoveries of Lewis will probably experience greater delay, and become known to the world through other channels before that volume will be ready."[35]

To add to this exasperating delay, the original botanical and other scientific notes became dispersed among different persons who were reluctant to surrender them into one complete collection. By his persistent efforts, however, and with the assistance of the Abbé Corrêa de Serra and others, he finally succeeded in rescuing a considerable portion of the original notes and in getting them into the hands of a publisher, Paul Allen, as well as depositing them, on April 8, 1818, for safe keeping with the American Philosophical Society. It was not until 1904, however, one hundred years after Lewis and Clark started their famous trip, that their journals were published in full and as originally written. Jefferson was thus deprived of seeing the full consummation of his great project, but the pride which he took in its botanical findings is well exemplified by the following letter of his in 1813 to Madame de Tessé, a relative of the Marquis de la Fayette, who apparently had established some new gardens at Auenay in France:

"With the botanical riches which you mention to have been derived to England from New Holland, we are as yet unacquainted. Lewis's journey across our continent to the Pacific has added a number of new plants to our former stock. Some of them are curious, some ornamental, some useful, and some may by culture be made acceptable on our tables. I have growing, which I destine for you, a very handsome little shrub of the size of a currant bush.

[34] Letter to Bernard McMahon, October 11, 1812 (14, LXII, No. 125).
[35] Letter to Baron Alexander von Humboldt, December 6, 1813 (13 XIV, *20*).

Its beauty consists in a great produce of berries of the size of currants, and literally as white as snow, which remain on the bush through the winter, after its leaves have fallen, and make it an object as singular as it is beautiful. We call it the snow-berry bush, no botanical name being yet given to it, but I do not know why we might not call it Chionicoccos, or Kallicoccoss. All Lewis's plants are growing in the garden of Mr. McMahon, a gardener of Philadelphia, to whom I consigned them, and from whom I shall have great pleasure when peace is restored [the war of 1812 was then raging], in ordering for you any of these or of our other indigenous plants."[36]

In concluding this chapter it is only fair to note that Jefferson's concern for the determination of plants in botanical collections was not limited to material assembled by Lewis. A certain Mr. Dunbar, for instance, conducted an excursion up the Washita in the autumn and winter of 1804, and the following May Jefferson sent dried plant specimens from that journey to Dr. Barton for determination.[36a]

ACADEMIC CONCERN FOR BOTANY IN CURRICULA

That Jefferson appreciated the cultural value of botanical studies is apparent from many of his writings. In a letter from Paris, for instance, which he addressed in 1787 to his future son-in-law, Thomas M. Randolph, Jr., who at the time was studying at the University of Edinburgh, Jefferson advised, among other matters, that:

"Mathematics, Natural Philosophy, Natural History, Anatomy, Chemistry, Botany, will become amusements for your hours of relaxation and auxiliaries to your principal studies. Precious and delightful ones they will be. As soon as such a foundation is laid in them, as you may build on as you please hereafter, I suppose you will proceed to your main objects, Politics, Law, Rhetoric and History."[37]

This observation is interesting not only in the thought contained in it, but because that thought was the direct converse of an idea which has long dominated in academic circles, even to very recent years, namely, that the so-called classics and cultural subjects should serve as a background for scientific pursuits. Many have been the embryonic and genuinely promising scientists who have wondered why they must delve into Greek, Latin, and perhaps ancient mythology, while students of the "classics" escaped the rigors of experimentation, analytic inquiry, and inductive reasoning. Perhaps Jefferson was a prophet here as elsewhere, for in the generations since him, the inherited awe for "classical" studies has very gradually relaxed in an increasing appreciation of the cultural values inherent in natural history.

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[36] Letter to Madame de Tessé, December 8, 1813 (13, XIV, *25*).

[36a] Two letters to Benjamin Smith Barton, May 2 & 21, 1805. (Library of Congress & Mass. Hist. Soc., according to citation No. 20.)

[37] Letter to Thomas Mann Randolph, July 6, 1787 (13, VI, *165*).

Twenty years later, when Jefferson was President of the United States and that son-in-law had his own son of college age, Jefferson displayed the same concern for his grandson. To Dr. Caspar Wistar, prominent among the learned men who seemed to be concentrated in those days around Philadelphia, he was induced to write as follows:

"I have a grandson, the son of Mr. Randolph, now about fifteen years of age, in whose education I take a lively interest . . . I am not a friend to placing young men in populous cities, because they acquire there habits and partialities which do not contribute to the happiness of their after life. But there are particular branches of science, which are not so advantageously taught anywhere else in the United States as in Philadelphia. The garden at the Woodlands for Botany, Mr. Peale's Museum for Natural History, your Medical school for Anatomy, and the able professors in all of them, give advantages not to be found elsewhere. We propose, therefore, to send him to Philadelphia to attend the schools of Botany, Natural History, Anatomy, and perhaps Surgery; but not of Medicine."[38]

To the grandson's father he wrote as follows respecting this contemplated tutelage under Dr. Wistar:

"For a scientific man in a town nothing can furnish so convenient an amusement as chemistry, because it may be pursued in his cabinet; but for a country gentleman I know no source of amusement & health equal to botany & natural history, & I should think it unfortunate for such an one to attach himself to chemistry."[39]

To someone who disagreed with him he wrote:

"In the exclusion of Anatomy and Botany from the eleventh grade of education, which is that of the man of independent fortune, we separate in opinion. In my view, no knowledge can be more satisfactory to a man than that of his own frame, its parts, their functions and actions. And Botany I rank with the most valuable sciences, whether we consider its subjects as furnishing the principal subsistence of life to man and beast, delicious varieties for our tables, refreshments from our orchards, the adornments of our flower-borders, shade and perfume of our groves, materials for our buildings, or medicaments for our bodies. To the gentleman it is certainly more interesting than Mineralogy (which I by no means, however, undervalue), and is more at hand for his amusements; and to a country family it constitutes a great portion of their social entertainment. No country gentleman should be without what amuses every step he takes into his fields."[40]

It was only natural, therefore, that when the opportunity presented itself, Jefferson became instrumental in fostering botanical studies. That opportunity came after his retirement from the Presidency of the United States, when he was in a position to give sustained attention to the new university which he had long been planning to erect in Charlottesville near his home

[38] Letter to Dr. Caspar Wistar, June 21, 1807 (13, XI, *242*).
[39] Letter to Thomas Mann Randolph, November 22, 1809 (18, *124*).
[40] Letter to Dr. Thomas Cooper, October 7, 1814 (13, XIV, *199*).

of Monticello. In writing to Joseph Priestley, the eminent English chemist, telling him of his plans for a university and soliciting his advice, Jefferson wrote:

"To you therefore we address our solicitations, and to lesson to you as much as possible the ambiguities of our object, I will venture even to sketch the sciences which seem useful and practicable for us, as they occur to me while holding my pen. Botany, chemistry, zoology, anatomy, surgery, medicine, natural philosophy, agriculture, mathematics, astronomy, geography, politics, commerce history, ethics, law, arts, fine arts."[41]

In 1803, as a result of Jefferson's endeavors, Albemarle Academy was founded. In 1817 it became Central College, and in 1825, in final consummation of Jefferson's long-cherished hope for a state university, the institution became the University of Virginia. It is particularly interesting to note that Jefferson had at one time hoped to place a botanist at the head of this institution, the Abbé José Francisco Corrêa da Serra.[42] This gentleman was a Portuguese politician, scholar and botanist who came to America in 1813 to prosecute researches in natural history, and who lectured for a time to the American savants gathered in Philadelphia when that city was the center of learning in the new republic. He had long been a friend of Jefferson, assisted him in planning the botany courses and garden at the University, and in 1816, instead of meeting Jefferson's wishes, became Portuguese Minister to the United States.

Constantine Samuel Rafinesque also entered into Jefferson's problems in connection with the set-up of the University. Like the two Michaux', he also was foreign-born and contributed much to early American botany. In 1819 he accepted a professorship in Transylvania University, Kentucky, but during the tenure of that office he was very anxious to become associated with Jefferson's new university. From correspondence between the two men (5) we learn that Rafinesque made repeated but vain overtures to Jefferson seeking his favor and courting an appointment from him to a position in the new institution. Jefferson appears not to have been particularly impressed by Rafinesque's qualifications, for his responses were rather equivocal, and before terminating his correspondence with Rafinesque, he sent a representative to Europe to engage professors for the University. As we shall soon note, it was a New Yorker who finally gained the coveted position.

It was also Jefferson's desire to have his university include a school of agriculture. The idea was not entirely new at that time, for nearly 20 years earlier he had also advocated establishing a school of agriculture in connection with his bold but vain suggestion to Washington that the great University of Geneva be bodily transferred from Switzerland to some place near

[41] Letter to Dr. Joseph Priestley, January 18, 1800 (13, X, *140*).
[42] Letter to M. Dupont de Nemours, November 29, 1813 (13, XIX, *195*).

the Federal city (Washington) in order that it might escape the Napoleonic scourge. Theodor de Saussure and Jean Senebrier were then associated with that institution, and in a few years they and Ingenhouss were destined to lay the foundations for a proper understanding of photosynthesis and respiration. In one of Jefferson's letters wherein he commented that

"The greatest evils of populous society have ever appeared to me to spring from the vicious distribution of its members among the occupations called for"

he also wrote:

"The class principally defective is that of agriculture. It is the first in utility, and ought to be the first in respect. The same artificial means which have been used to produce a competition in learning, may be equally successful in restoring agriculture to its primary dignity in the eyes of men. It is a science of the very first order. It counts among its handmaids the most respectable sciences, such as Chemistry, Natural Philosophy, Mechanics, Mathematics generally, Natural History, Botany. In every College and University, a professorship of agriculture, and the class of its students, might be honored as the first. Young men closing their academical education with this, as the crown of all other sciences, fascinated with its solid charms, and at a time when they are to choose an occupation, instead of crowding the other classes, would return to the farms of their fathers, their own, or those of others, and replenish and invigorate a calling, now languishing under contempt and oppression. The charitable schools, instead of storing their pupils with a lore which the present state of society does not call for, converted into schools of agriculture, might restore them to that branch qualified to enrich and honor themselves, and to increase the productions of the nation instead of consuming them."[43]

It must be borne in mind, when evaluating this comment, that Jefferson was not in favor of an industrialized America; he wanted it to develop primarily into an agricultural nation; his enthusiasm for agriculture, therefore, was not merely part of his broadness of mind but was an expression of the destiny, as he saw it, of his country. Others, however, did not share his convictions, and an agricultural school was not included in the University as finally founded, probably "because of the contempt felt by the votaries of higher classicism for so plebeian a pursuit" (30). Instead, a separate college of agriculture was founded at Blacksburg, Virginia.

The University did, however, acquire a school of natural history, headed by Dr. John P. Emmett of New York, who in his capacity of Professor was called upon to teach not only botany but also chemistry, geology, mineralogy, and zoology. Jefferson recommended in one of his last letters that Emmett give twelve dozen lectures per year, two dozen to botany and zoology, two dozen to mineralogy and geology, and eight dozen to chemistry.[44]

[43] Letter to David Williams, November 14, 1803 (13, X, *428*).
[44] Letter to Dr. John P. Emmett, May 2, 1826 (13, XVI, *170*).

Jefferson was also interested in establishing a botanical garden at the university but the idea never materialized. Emmett was primarily a chemist by training, and any preferences which he may have exercised toward test tubes and crucibles, together with the responsibility of teaching other physical sciences, postponed his developing the biological part of his curriculum. A year after his appointment botanical courses had apparently not yet been inaugurated, for Jefferson at that time found occasion to pen one of the last letters of his life in which he revealed once again his long-sustained interest in plant life, more particularly in revealing it to students. He wrote that letter on April 27, 1826, to Dr. Emmett. A little more than two months later he died. To quote this communication seems, therefore, a most appropriate means of concluding this tribute to the purely botanical interests of Thomas Jefferson:

"It is time to think of the introduction of the School of Botany into our institution. Not that I suppose the lectures can be begun in the present year, but that we may this year make the preparations necessary for commencing them the next. For that branch, I presume, can be taught advantageously only during the short season while nature is in general bloom, say during a certain portion of the months and April and May, when, suspending the other branches of your department, that of Botany may claim your exclusive attention. Of this, however, you are to be the judge, as well as of what I may now propose on the subject of preparation."

Jefferson then refers to several suggestions which he had solicited and received from the late Abbé Corrêa regarding the designs for a botanic garden. Six acres of land were available for the purpose. Flower-beds and an arboretum were to be instituted, but a greenhouse, owing to lack of funds, could not be considered. He then continues:

"1. Our first operation must be the selection of a piece of ground of proper soil and site, suppose of about six acres, as M. Corrêa proposes. In choosing this we are to regard the circumstances of soil, water, and distance. I have diligently examined all our grounds with this view, and think that that on the public road, at the upper corner of our possessions, where the stream issues from them, has more of the requisite qualities than any other spot we possess. . . .

"2. Operation. Enclose the ground with a serpentine brick wall seven feet high. This would take about 80,000 bricks, and cost $800, and it must depend on our finances whether they will afford that immediately, or allow us, for awhile, but enclosure of posts and rails.

"3. Operation. Form all the hillsides into level terrasses of convenient breadth, curving with the hill, and the level ground into beds and alleys.

"4. Operation. Make a list of the plants thought necessary and sufficient for botanical purposes, and of the trees we propose to introduce, and take measures in time for procuring them.

As to the seeds of plants, much may be obtained from the gardeners of our own country. I have, moreover, a special resource. For three and twenty

years of the past twenty-five, my good friend Thouin, Superintendent of the Garden of Plants at Paris, has regularly sent me a box of seeds, of such exotics as to us, as would suit our climate, and containing nothing indigenous to our country. These I regularly sent to the public and private gardens of the other States, having as yet no employment for them here. But during the last two years this envoi has been intermitted, I know not why. I will immediately write and request a recommencement of that kind office, on the ground that we can now employ them ourselves. They can be here in the early spring.

The trees I should propose would be exotics of distinguished usefulness, and accommodated to our climate; such as the Larch, Cedar of Libanus, Cork Oak, the Marronier, Mahogany, the Catachu (i.e., caoutchouc) or Indian rubber tree of Napul (30), Teak tree, or Indian oak of Burman (23), the various woods of Brazil, etc.

The seed of the Larch can be obtained from a tree at Monticello. Cones of the Cedar of Libanus are in most of our seed shops, but may be had fresh from the trees in the English gardens. The Marronier and Cork Oak, I can obtain from France. There is a Marronier at Mount Vernon, but it is a seedling, and not therefore select. The others may be got through the means of our ministers and consuls in the countries where they grow, or from the seed shops of England, where they may very possibly be found. Lastly, a gardener of sufficient skill must be obtained.

This, dear Sir, is the sum of what occurs to me at present; think of it, and let us at once enter on the operations."[45]

JEFFERSONIA

Jefferson was long associated with and at one time the third president of the American Philosophical Society, which revolved about the learned gentlemen who congregated in Philadelphia during the American colonial days. Among the members was Benjamin Smith Barton, professor of natural history, botany, and materia medica in Philadelphia College, which later became the University of Pennsylvania. It seems most fitting, in view of Jefferson's enduring interest in plants, that Dr. Barton and the Society, through their transactions of 1793 should have commemorated that interest by establishing a new genus of plants in his honor, *Jeffersonia*. In establishing the genus, Barton wrote:

"*Jeffersonia*, in honour of Thomas Jefferson, Esq., Secretary of State to the United States. I beg leave to observe to you, in this place, that in imposing upon this genus the name of Mr. Jefferson, I have had no reference to his political character, or to his reputation for general science, and literature. My business was with his knowledge of natural history. In the various departments of this science, but especially in botany and in zoology, the information of this gentlemen is equalled by that of few persons in the United States."[46]

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[45] Letter to Dr. John P. Emmett, April 27, 1826 (13, XVI, *163*).

[46] Trans. Am. Phil. Soc. 3: 342. 1793.

It is to be noted that this dedication was made before Jefferson distinguished himself in sponsoring the Lewis and Clark Expedition or urging agricultural and botanical studies. It was inspired, presumably, by his interest in agriculture and the introduction of new and valuable crop plants, by his gardening activities to be considered later, and by other considerations not revealed in his writings but undoubtedly well known to his contemporaries.

The genus thus established was monotypic at the time, and Barton named the one species *Jeffersonia binata*, the natural distribution of which today is known to extend from New York and Ontario to Wisconsin, Iowa, and Tennessee. Linnaeus, 40 years earlier, had named it *Podophyllum diphyllum*, and Persoon, after Barton, called it *Jeffersonia diphylla*, where it stands today. The plant is an herbaceous perennial of the Berberidaceae, popularly known as twin-leaf or rheumatism-root, and its rhizomes and roots have been used as adulterants and substitutes of those of *Aristolochia Serpentaria*, *A. reticulata*, and *Hydrastis canadensis*. The first two of these, known respectively as Virginia and Texas snakeroot, are the commercial sources of serpentaria, a pharmaceutical preparation of several alleged attributes but used principally in treatment of bronchitis and as an aromatic bitter. The dried rhizomes and roots of *Hydrastis* or goldenseal are used as alteratives to mucous membranes and as bitter tonics.

RESUMÉ

Jefferson's claim to fame in the realm of pure botany lies solely in the botanical aspects of two great projects which he conceived and executed, namely, the Lewis and Clark Expedition from St. Louis to the Pacific Coast, and the founding of the University of Virginia. Among the fruits of the former was a collection of plants, in the naming and preservation of which Jefferson was much concerned; and as part of the latter, he sponsored a school of botany which was established, and a botanical garden which never materialized. Outside his sponsorship of these two successful enterprises he contributed nothing by way of personally adding to the contemporary understanding of plants. That he was a profound admirer of plants and well acquainted with them is another matter, and in the next, third and last part of this series we shall consider the abundant and impressive evidence in that direction.

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THE GENUS JATROPHA IN AMERICA: PRINCIPAL INTRAGENERIC GROUPS

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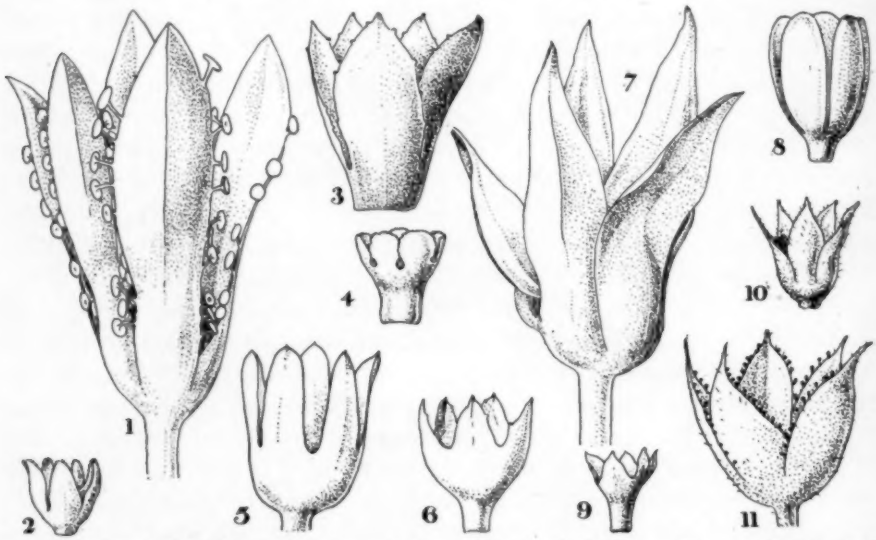
The euphorbiaceous genus *Jatropha* comprises perhaps 125 species, most of which are American or African; probably 40–50 species are African and about 75 American; a few are natives of Arabia or the southern Indian region. The closest affinities of the genus appear to be with *Manihot* and *Cnidoscolus;* it has likewise considerable apparent affinity with *Aleurites* and with *Hevea*, but these latter genera are usually referred to another tribe on the basis of technical characters of calyx aestivation. Several species of *Jatropha*, originally American, have become widely dispersed in the tropics because of their cultivation for ornament, for shade trees or for medicinal purposes, and at least a few species of the genus are familiar to many botanists and collectors, so that the name *Jatropha* is a familiar one in botanical literature. At least one species, *J. Curcas*, has attained much notoriety as a common poisonous plant of the tropics, and more lately has been thought of as a possible source of a drying oil similar to tung oil. Botanically the genus has received its share of attention, with the usual concomitant duplication of names for species and other subgeneric groups, and misapplication of names; as in any generic group of similar size, new entities have been discovered from time to time since the publication of the last treatment of the genus as a whole, and a modern synopsis of all the American species would be of value to working systematists. As a step preliminary to this, the present paper attempts to set forth what appear to be the principal lines of divergence within the genus; at the present time it is impracticable to prepare a detailed synopsis of all species, chiefly because so many are poorly known. For example, to consider the situation in North America alone, at the time of publication of Standley's *Trees and Shrubs of Mexico* (1923) its author included 19 distinct and well-marked species of *Jatropha* (excluding *Cnidoscolus*); 6 of these were scarcely or not at all known except from the type, and not more than 8 were represented in herbaria by enough material to give a fair idea of the species. Since 1923 about 8 species have been added to the known flora of Mexico, 7 of which are known from the type only or from very scanty material.

SUMMARY OF PREVIOUS CLASSIFICATION OF THE GENUS

Detailed taxonomic studies of *Jatropha* have been two: The genus was written up by Mueller for the DeCandolle *Prodromus* (1866) and by Pax

for *Das Pflanzenreich* (1910). Both these authors included in *Jatropha* the species with stinging hairs and a single floral envelope, the group long before segregated by Pohl as a genus, *Cnidoscolus*. I have set forth elsewhere my reasons for maintaining the latter as distinct from *Jatropha* (McVaugh 1944).

Mueller divided *Jatropha* into three sections, making *Cnidoscolus* equal in rank to the others, *Adenorhopium* and *Curcas*. It now appears that although his major divisions were well founded, the two latter sections are much more closely related to one another than to *Cnidoscolus*. *Adenorhopium*



Calyces of *Jatropha*, 5 times natural size. FIG. 1. *Jatropha cordata*, ♀, *Gentry 2275*, Sonora. FIG. 2. *J. cordata*, ♂, *Gentry 2274*, Sonora. FIG. 3. *J. macrantha*, ♂, *Balls 5878*, Peru. FIG. 4. *J. Humboldtiana*, ♂, *Weberbauer 6211*, Peru. FIG. 5. *J. integerrima*, ♀, *Fennell 462*, from cultivation. FIG. 6. *J. integerrima*, ♂, *Lundell 1597*, Petén. FIG. 7. *J. Curcas*, ♀, *Pittier 2400*, Panama. FIG. 8. *J. Curcas* var. *rufus*, ♂, *Ortega 7299*, Sinaloa. FIG. 9. *J. cathartica*, ♂, Texas. FIG. 10. *J. excisa*, ♂, *Venturi 7991*, Argentina. FIG. 11. *J. excisa*, ♀, *Venturi 7991*.

and *Curcas*, indeed, are separable with some difficulty, the sectional lines having in the past been drawn chiefly upon a single character, the degree of coherence of the petals of the pistillate flower.[1] In his division of the genus Mueller was followed closely by Pax, who used the same criteria for delimitation of the groups, which he considered subgenera ("Untergattungen") rather than sections.

Mueller's treatment of *Jatropha* was rather strongly influenced by the previous work of Baillon (1858), who had proposed to take up Adanson's

[1] DC. Prodr. 15(2): 1076. 1866. "[Sect. Curcas] a sect. Adenorhopio vix nisi petalis florum foem. arctissime cohaerentibus differt."

genus *Curcas* for those species having a gamopetalous corolla, and to restrict the use of the name *Jatropha* to the polypetalous species. Baillon's genus *Jatropha* thus included *Adenoropium* of Pohl as an exact synonym, but while Pohl had segregated the species of *Adenoropium* from *Jatropha* chiefly on the basis of the abundant foliar and other glands of the species known to him, Baillon relied upon the corolla-character. Many of the species accepted by Baillon as polypetalous are not so, and the character is at best of doubtful value in classification in this group. Whatever the wisdom of his course, however, Baillon's ideas on the relationships of species seem to have been accepted by Grisebach, (1864, p. 36) who assigned *J. gossypifolia*, *J. multifida*, *J. hastata* Jacq., and *J. divaricata* Sw. to a new section, *Adenorhopium*[2] (subsequently taken up by Mueller) which he described as having "Petals distinct, or cohering at the base." Grisebach's second section, *Curcas*, included *J. hernandifolia* Vent., and *J. Curcas*, and was apparently based on Baillon's conception of the genus *Curcas*, for it is described as having the "Corolla sympetalous."

The above arrangement of the genus, based on the single corolla-character, is actually somewhat too simple to be a natural one. All the American species known to me, however, may be separated into four principal groups, each of which is more homogeneous than either of the great sections accepted by most authors. Of these four one is chiefly Mexican, one Antillean, one Andean, and one appears to be best developed in the south-Brazilian— Paraguayan region. They may be distinguished as follows:

1. Calyx in both staminate and pistillate flowers scarious or subherbaceous, the pistillate sometimes larger but not conspicuously different otherwise from the staminate; calyx-lobes little or not at all imbricated at anthesis, often separated by broad rounded sinuses; petals distinct or essentially so, scarlet to vermilion ..... 2.

2. Petals hirsute within at base; style-tips slender, margined and hooded by the stigmatic surfaces; stamens 10, the anthers sagittate, at least the inner ones strongly curved ..... Sect. *Polymorphae* Pax.

2. Petals glabrous; style-branches with fleshy capitate stigmatic tips; stamens 8, the anthers usually long-linear, erect ..... Sect. *Macranthae* Pax.

1. Calyx of the pistillate flowers usually definitely herbaceous, usually larger than and often conspicuously different from that of the staminate, which may be herbaceous or scarious; calyx-lobes usually imbricate even until anthesis, the sinuses very narrow; corolla definitely tubular (usually at least a third its length), campanulate to cylindric, variously colored but rarely bright red as in no. 1, above ..... 3.

3. Calyx in both sexes herbaceous, the lobes usually glandular-margined; plants monoecious, usually with many small glands on leaf-margins,

[2] This spelling is that used by Grisebach and is etymologically correct, but is not that used by Pohl, although Grisebach doubtless intended to base his section upon Pohl's genus. Since Grisebach made no mention of Pohl's work, there would appear to be no justification for citing the name of the latter as a parenthetical authority for the sectional name, regardless of the essential identity of the two groups and the probable intentions of the later author.

bracts and stipules; stamens usually 8, the anthers short and broad; corolla purple to purple-red or yellow, the tube usually shorter than the lobes; seeds with small scar and large fimbriate caruncle ... Sect. *Adenorhopium* Griseb.

3. Pistillate calyx usually herbaceous, the lobes sometimes glandular-margined; staminate calyx quite different in aspect, more or less scarious, the lobes usually entire; plants (sometimes monoecious) usually polygamous or dioecious; most species not or but sparsely glandular; stamens usually 10, the anthers short and broad; corolla green or yellow to white, pink, or sometimes red, the tube usually longer than the lobes; seeds (often rounded) mostly with a broad irregular scar and a small caruncle. Sect. *Mozinna* (Ortega) Pax.

1. Sect. POLYMORPHAE Pax, Pflanzenreich IV. **147**: 48, emend. 1910.

Jatropha, subgen. *Adenoropium*, sect. *Polymorphae* Pax, l.c., as to type species.

The plants of this section are shrubs or trees with sticky watery sap (according to Jacquin) and small pith. The leaves are palmately veined (or in entire or subentire forms pinnately veined except for the two strong ascending basal veins); blades often with a few glandular teeth, especially near base; stipules small, subulate, and entire; inflorescence corymbose, the lower branches alternate; petals distinct, bright red, 10–15 mm. long, narrowed to a very short claw; calyx campanulate, with blunt lobes which are entire or few-toothed, scarcely imbricate even in bud; stamens 10 in 2 whorls; styles 3, deeply cleft into two filiform hooded tips; glands 5, free; fruits small, dry; seeds oblong, with reflexed and lacerate caruncle and small hilum.

LECTOTYPE-SPECIES. *Jatropha integerrima* Jacq.

Pax included here 8 Cuban and 5 African and Arabian species; material of the Old World species [*J. unicostata* Balf. f., *J. variegata* (Forsk.) Vahl, *J. capensis* (L. f.) Sond., *J. variifolia* Pax, and *J. prunifolia* Pax] has not been available for study, but all appear from descriptions to agree in having 8 (not 10) stamens, and most are said to have lobed or dissected stipules and greenish or yellowish (not red) petals, so their relationships to the Cuban species are probably not close. The use of the name *Polymorphae* may accordingly be restricted to the Cuban species, the disposition of the Old World species being left for the future.

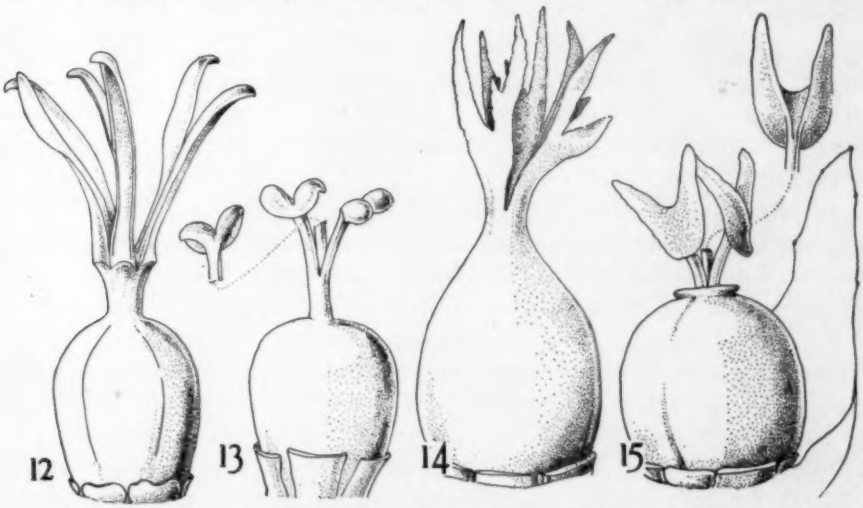
This group is, so far as known, restricted to the Greater Antilles except as found in cultivation elsewhere in the tropics and occasionally established; the species are probably all originally natives of Cuba only. The described species number about 12; in 1910 Pax recognized but 8, admitting at the same time that *J. panduraefolia*, *J. integerrima*, *J. hastata*, *J. glaucovirens*, and *J. pauciflora* were inseparable except by leaf-characters. Actually there seem to be not more than three or four species, including *J. angustifolia* Griseb., *J. tupifolia* Griseb., *J. Paxii* Croiz., and the group of *J. integerrima* Jacq.; the latter is an extremely variable species (as to form of leaves), long cultivated in Cuba under the name of "peregrina," and many times described botanically. I am referring to this species, as synonyms, *J. hastata* Jacq., *J. acuminata* Desr., *J, panduraefolia* Andr., *J. diversifolia* A. Rich.,

J. moluensis Sessé & Moc., *J. glaucovirens* Pax & Hoffm., and *J. pauciflora* Griseb. *Jatropha minor* Urb., said to be related to *J. tupifolia*, is unknown to me. Apparently *J. hastata* Jacq. and *J. integerrima* Jacq., the earliest (and simultaneously published) names for this species, have never before been combined under the one name or the other, although they have been combined several times under other names, especially under *J. diversifolia*, which was originally published to include both, and under *J. panduraefolia*.

2. Sect. MACRANTHAE Pax, Pflanzenreich IV. **147**: 46, emend. 1910.

Jatropha subgen. *Adenoropium*, sect. *Macranthae* Pax, l.c. as to type; sect. *Glanduliferae*, subsect. *Lobatae* Pax, op. cit. 31, pars; subsect. *Pubescentes* Pax, op. cit. 37, pars; subsect. *Multifidae* Pax, op. cit. 40, pars; subsect. *Peltatae* Pax, op. cit. 43; subgen. *Curcas*, sect. *Mozinna*, subsect. *Mutabiles* Pax, op. cit. 83.

Monoecious shrubs or small trees, or fleshy herbs with stout woody bases, often with peltate or subpeltate leaves; stipules various, often dissected and



Pistils of *Jatropha*, 10 times natural size. FIG. 12. *J. integerrima, Fennell 462.* FIG. 13, *J. gossypifolia, Orcutt 3407*, Mexico. FIG. 14. *J. Gaumeri*, from the type. FIG. 15. *J. macrantha, Balls 5878*, Peru.

glandular, and sometimes persistent and indurated; inflorescence mostly corymbose, pedunculate, the lower branch or branches of the cyme alternate; petals large and showy (mostly 1–1.5 cm. long), distinct or essentially so, usually glabrous, scarlet or vermilion to yellow; calyx more or less scarious and nearly smooth in flowers of both sexes, the lobes often short and blunt, usually little or not at all imbricate except in bud, the tube often relatively long; stamens usually 8 (5 in the outer whorl), the anthers elongate, linear, sagittate; styles 2-cleft, mostly slender and elongate, the stigmas capitate or horseshoe-shaped, fungoid-fleshy; floral glands distinct or in some species truly annular; seeds with small scar and large fimbriate caruncle.

TYPE-SPECIES, *Jatropha macrantha* Muell. Arg.

Species of this section are readily to be separated from those of sect. *Adenorhopium* by the corolla characters, the elongate anthers, the tendency of the calyx to become scarious, and the relative lack of stipitate glands (most species of *Adenorhopium* have copious glands on the petioles, along the leaf-margins and on the calyx).

All the species now assigned to sect. *Macranthae* (except *Jatropha mutabilis*) were originally placed by Pax in his subgenus *Adenoropium*, but the section as originally constituted was a heterogeneous one of 5 species with little in common, set off by Pax on the basis of their much-reduced stipules. The original species of the section were *J. ciliata* Muell. Arg., *J. macrocarpa* Griseb., *J. macrantha* Muell. Arg., *J. pachypoda* Pax. and *J. Andrieuxii* Muell. Arg. Subsequently described species to be added to the narrowly circumscribed section are *J. Augusti* Pax & Hoffm., *J. Hoffmanniae* Croiz. (*J. longipedunculata* Pax & Hoffm.), *J. multiflora* Pax & Hoffm., and *J. papyrifera* Pax & Hoffm.

Mueller (1866) recognized the homogeneity of the group *Macranthae* (in the present enlarged sense), and grouped the nine species known to him into one of the six divisions of his section *Adenorhopium;* the only exception to this was *J. macrantha*, of which he had incomplete material, and which he set up in a distinct group.

In contrast to Mueller, Pax distributed the 11 species known to him in 1910 (excluding those placed by him in *Macranthae*) among 4 subsections of his section *Glanduliferae*, and set up for *J. mutabilis*, which was unknown to Mueller, a monotypic subsection in his subgenus *Curcas*. Pax's disposition of the species was as follows: Subsection *Lobatae* (*J. ricinifolia* Pax, *J. Hieronymi* Kuntze, *J. Weddelliana* Baill.); Pubescentes [*J. Martiusii* (Pohl) Baill., *J. Pohliana* Muell. Arg.]; Multifidae (*J. multifida* L., *J. Berlandieri* Torr.); *Peltatae* (*J. peltata* H.B.K., *J. podagrica* Hook., *J. Weberbaueri* Pax & Hoffm., *J. nudicaulis* Benth.). The subsequently described *J. grossidentata* Pax & Hoffm. is said to be closely related to *J. Weddelliana*.

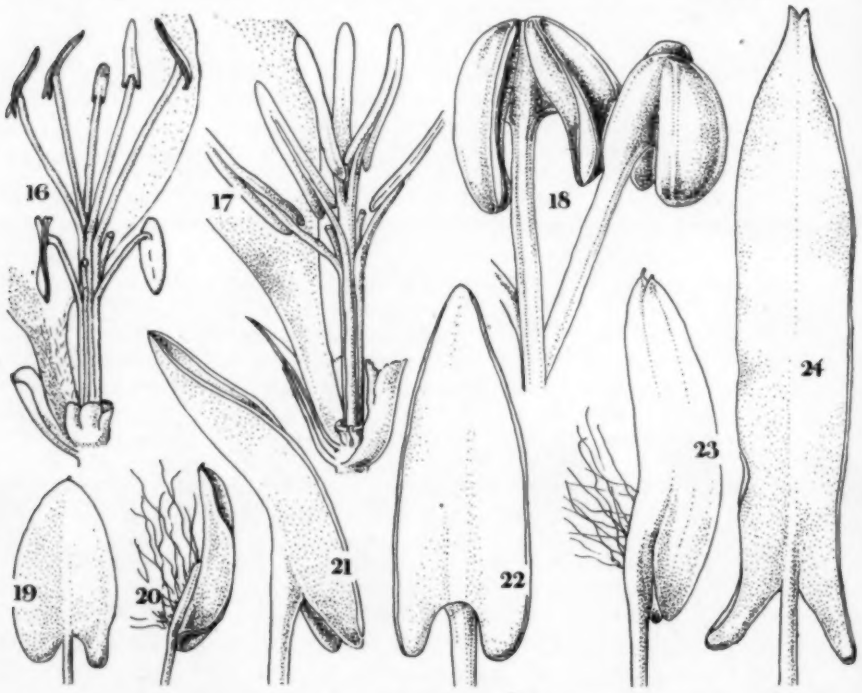
The subsections constituted by Pax were distinguished almost wholly on gross characters of the leaves (degree of lobing, amount of pubescence, etc.), but it seems that a better idea of relationships may be obtained by study of the floral structures of these species with variable leaves, so that (African species excluded) I should leave intact but one of Pax's subsections of his sect. *Glanduliferae*, namely subsect. *Adenophorae*, which he based chiefly upon the glandular petioles of the included species. The above species, with those from sect. *Macranthae* as understood by Pax, may then be disposed of as follows:

1. Shrub with leaves rounded, small, entire or denticulate, to 3.5 cm. long, on petioles 5 mm. long or less; calyx-lobes thickly glandular-margined, pubescent, not scarious; stipules minute, subulate, deciduous; stamens 8; eastern Brazil (Bahia, Alagoas) ..... *J. mutabilis* (Pohl) Baill.

1. Leaves various, usually at least 10 cm. broad, variously lobed and toothed, long-petiolate ..... 2.
2. Stipules reduced to sessile glands or minute and indurated ..... 3.
3. Leaf-margins glandular-serrate or glandular-denticulate ..... 4.
4. Leaves with shallow triangular lobes; stamens 8 (or 9); southern Peru ..... *J. ciliata, J. Augusti, J. Hoffmanniae.*
4. Leaves divided nearly to base into elliptic lobes; stamens unknown; plants (?always) dioecious, with 5 carpels; Bolivia ..... *J. pachypoda.*
3. Leaves deeply 3- or 5-lobed, the margins of the lobes entire; carpels 3; stamens 10 ..... 5.
5. Leaves usually 3-lobed; inflorescence corymbose, congested, few-flowered; corolla scarlet; Atlantic slope of northern Peru ..... *J. macrantha.*
5. Leaves usually 5-lobed; inflorescence much elongated (to 20-30 cm.) and many-flowered, falsely racemose, bearing short lateral cymes; corolla red and yellow or orange (or white); northern Argentina and Bolivia ..... *J. macrocarpa, J. papyrifera.*
2. Stipules setaceous-dissected, usually gland-tipped, often persistent ..... 6.
6. Leaves definitely peltate; stamens 8 ..... 7.
7. Leaf-margins ciliate with slender stalked glands; northern Amazonian Peru ..... *J. Humboldtiana* McVaugh (*J. peltata* H.B.K.).
7. Margins of lobes entire or dentate, sometimes apiculate, not glandular-ciliate ..... 8.
8. Stipules indurate, the persistent woody bases antler-like; margins of lobes entire ..... 9.
9. Stipules glabrous; floral gland annular; calyx-lobes roundish, nearly entire, about 1.5 mm. long; corolla-lobes up to 8 mm. long; Central America and in cultivation ..... *J. podagrica.*
9. [Stipules with long matted deciduous hairs; floral glands distinct; calyx-lobes (pistillate) acuminate; corolla 10 mm. long; Colombia and Ecuador, not seen] ..... *J. nudicaulis.*
8. Stipules delicate, not indurated at base; margins of lobes entire or with few large teeth; Amazonian Peru ..... *J. Weberbaueri.*
6. Leaves not peltate, deeply palmately divided ..... 10.
10. Leaves with (5) 7–13 narrow divisions, these usually irregularly and coarsely lobulate, rarely entire, never regularly denticulate ..... 11.
11. Stem herbaceous, to about 0.3 m. high; stipules 2–3 mm. long, bifid or trifid; Texas and northern Mexico. *J. cathartica* Ter. & Berl. (*J. Berlandieri*).
11. Shrub or small tree to 6 or 7 m. high; stipules 1–2 cm. long, much dissected; tropical America; much in cultivation ..... *J. multifida.*
10. Leaves palmately 3- to 5- (7-) lobed, the lobes toothed or entire, never irregularly lobulate ..... 12.
12. Leaf-margins serrulate, dentate or ciliate-denticulate, the teeth not gland-tipped; stamens 8; carpels 3; eastern Brazil to northern Argentina. *J. Weddelliana, J. Hieronymi, J. ricinifolia, J. Martiusii, J. mollissima* (Pohl) Baill. [*J. Pohliana*], *J. grossidentata.*
12. Leaf-margins glandular-serrulate; stamens 10 (? always); carpels 5 (?always); Bolivia ..... *J. pachypoda, J. papyrifera.*

Jatropha Robertii S. Moore, from Corumbá, Brazil, is unknown to me, but evidently belongs to *Macranthae*, as the stamens are said to be 8 in num-

ber, and the petals pink and distinct; the stipules are unknown and the leaf-margins are entire or undulate. *J. Andrieuxii*, assigned by Pax to sect. *Macranthae*, certainly belongs with the other Mexican species of *Mozinna*. As indicated above, I should transfer *J. mutabilis* from *Mozinna* to *Macranthae*, for its flowers, except for the hairy glandular calyx-lobes, are exactly typical of the latter section; Pax seems to have erected the subsection *Muta-*



Androecia (5 times natural size) and anthers (25 times natural size) of *Jatropha*. FIG. 16. *J. integerrima*, Mo. Bot. Gard. no. 266/04/47, *Thompson 95*, from cultivation. FIG. 17. *J. ciliata* Muell. Arg., *Herrera 3053*, Peru. FIG. 18. Anthers of *J. gossypifolia*, *Steere 1759*, Campeche. FIG. 19. Outer (lower) anther, ventral (outer) face, *J. platanifolia*, from an isotype. FIG. 20. Inner anther, lateral view, of the same. FIG. 21. Inner anther, lateral view, *J. integerrima*, *Thompson 95*. FIG. 22. Same, ventral face. FIG. 23. Inner anther, lateral view, *J. Curcas*, *Popenoe 395*, from cultivation. FIG. 24. Inner anther, ventral face, *J. ciliata* Muell. Arg., *Stork et al. 10530*, Peru.

Most of the drawings were made by Mr. B. Y. Morrison, from my sketches and notes.

biles wholly upon the superficial similarity between the leaves and twigs of *J. mutabilis* and those of several Mexican species of *Mozinna*.

It will be noted that no attempt has been made, in the key, to separate *J. ciliata* Muell. Arg. from the species supposedly related to it; the material at my disposal is entirely inadequate for the revision of this small group, but it appears that *J. Augusti* Pax & Hoffm. will have to be taken up for *J.*

ciliata, which is preoccupied by *J. ciliata* Sessé. The species of the group including *J. Weddelliana*, *J. mollissima* and *J. ricinifolia* are separated by Pax on the basis of pubescence alone and further study may show the number of species to be somewhat less than now supposed. The name *J. Pohliana*, used by Mueller and Pax, must be supplanted by one of the names proposed earlier by Pohl, and *J. mollissima* seems most suitable. *Jatropha pachypoda* is unknown to me except from a photograph of the type (*Fiebrig 3040a*, Field Mus. neg. 5396); this plant bears a strong superficial resemblance to *J. mollissima* and its relatives, suggesting the necessity of a careful study of additional material to determine the actual number of stamens and carpels normal for the species.

I have not attempted to subdivide the *Macranthae* into subsections, but on the basis of floral characters and those of the inflorescence, respectively, the aberrant species appear to be *J. macrantha* and *J. macrocarpa*.

3. Sect. ADENORHOPIUM Griseb. Fl. Br. W. Ind. 36, emend. 1864.

Adenoropium Pohl, Pl. Bras. Ic. 1: 12, *pl. 9*, as to type species. 1827; *Jatropha*, untergatt. *Adenoropium* (Pohl) Pax, Natürl. Pflanzenfam. 3(5): 75, as to type species. 1890; subgen. *Adenoropium*, sect. *Glanduliferae*, subsect. *Adenophorae* Pax, Pflanzenreich IV. 147: 25, in clavi. 1910; subsect. *Purpureae* Pax, op. cit. 26; sect. *Tuberosae*, subsect. *Latifoliae* Pax, op. cit. 60, in clavi (pars); subsect. *Macrorrhizae* Pax, op. cit. 61, pars.

Monoecious shrubs or herbs with glandular herbage, the leaf-margins, calyx-lobes, stipules and usually the petioles beset with stipitate glands; stipules dissected and glandular; inflorescence corymbose, the lowest branch or branches alternate; corolla relatively small (mostly less than 1 cm. long) definitely tubular, the segments loosely coherent one-third to one-half their length, mostly entirely glabrous, in color purplish-red to yellow, often with a pale tube; calyx usually herbaceous in flowers of both sexes, usually pubescent, with imbricate lobes; stamens usually 8, the anthers short, the inner three in many species with divergent sacs; styles 2-cleft, often short (?), the stigmas capitate or horseshoe-shaped, fungoid-fleshy; floral glands distinct; seeds with small scar and large fimbriate caruncle.

TYPE-SPECIES, *Jatropha gossypifolia* L.

Most if not all the African and Arabian species appear to belong to this section, having 8 stamens, yellow to purple corolla, glandular foliage, divided or reduced stipules and a lacerate or fimbriate caruncle; definite diposition of the Old World species must await further study.

The American species of *Adenorhopium* include several closely related South American species and two aberrant North American species; these may be arranged as follows:

1. Leaves more or less incised-serrate, at least the tips of the lobes with spinulose teeth, the margins not glandular; calyx somewhat scarious, the lobes long and narrow, fimbriate-toothed, not glandular; stamens 10; southwestern United States and northwestern Mexico ..... *J. macrorhiza* Benth.

1. Plants with glandular herbage, the leaf-margins and calyx-lobes not as above; stamens 8 or 10 ..... 2.

2. Leaves slender-petiolate, glabrous, the petioles eglandular, the blades small, up to about 3.5 cm. long, truncate at base, hastately 3-lobed with the middle lobe narrow, caudate or acuminate; Sinaloa and Sonora ... *J. purpurea* Rose.

2. Leaves elliptic to ovate and unlobed, nearly sessile, or palmately parted or lobed, then with slender glanduliferous petioles; stamens 8–10 ..... 3.

3. Leaves broadly elliptic or rounded to ovate, neither lobed nor divided, essentially entire and usually glabrous except for the densely glandular-ciliate margins; petioles 3–6 mm. long or less; stamens 8(–10); southeastern Brazil, Paraguay, northern Argentina and eastern Bolivia ..... *J. eglandulosa* Pax, *J. elliptica* (Pohl) Muell. Arg., *J. intermedia* (Chod. & Hassl.) Pax, *J. Isabelli* Muell. Arg. and var. *antisiphilitica* (Speg.) Pax, *J. puncticulata* Pax & Hoffm., *J. rigidifolia* Pax & Hoffm.

3. Leaves more or less palmately lobed (or on some plants partly unlobed), usually with definite slender glanduliferous petioles; stamens 8–10 ..... 4.

4. Stems herbaceous, simple or sparsely branched; petioles much shorter than the blades, mostly 1–2(4) cm. long; inflorescence few-flowered, compact, usually not surpassing the leaves; Paraguay and adjacent Brazil and Argentina.

J. Isabelli Muell. Arg. (?), *J. dissecta* (Chod. & Hassl.) Pax, *J. rigidifolia* Pax & Hoffm., *J. brachypoda* Pax, *J. induta* (Chod. & Hassl.) Pax, *J. transiens* Pax.

4. Stems usually definitely shrubby, copiously branched; petioles usually elongated and about equalling the blades, often 4–8(12) cm. long; inflorescence often surpassing the leaves, the main axis and lower branches often elongated ..... 5.

5. Petioles with expanded foliaceous margins, the margins glandular; northwestern Argentina ..... *J. Peiranoi* Lourt. & O'Don.

5. Petioles not foliaceous-margined ..... 6.

6. Leaves not lobed as deeply as to the middle of the blade; Paraguay and adjacent Brazil and Argentina ..... 7.

7. Staminate sepals entire.

J. Katharinae Pax, *J. ribifolia* (Pohl) Baill.

7. Staminate sepals glandular-ciliate.

J. guaranitica Speg., *J. Bornmülleri* Pax, *J. breviloba* (Morong) Pax & Hoffm.

6. Leaves lobed to the middle of the blade or (usually) more deeply ..... 8.

8. Inflorescence usually many-flowered, elongated, much exceeding the leaves, its lateral branches alternate, loosely flowered; stamens (?always) 10; petiolar glands simple and sparingly branched on the same leaf; Bolivia, northern Argentina and Paraguay.

J. excisa Griseb., *J. flavovirens* Pax & Hoffm., *J. thyrsantha* Pax & Hoffm.

8. Inflorescence few-flowered or if many-flowered the lateral branches bearing small dense flower-clusters; flowers usually not much if at all exceeding the leaves; stamens 8(or 10); petiolar glands various ..... 9.

9. Petiolar glands simple, clavate; leaves deeply parted; Bolivia ..... *J. clavuligera* Muell. Arg.

9. Petiolar glands predominantly several-branched, sometimes a few simple.
J. gossypifolia L., *J. pedatipartita* Kuntze, *J. intercedens* Pax, *J. hippocastanifolia* Croiz., *J. malmeana* Pax & Hoffm., *J. tacumbensis* Pax & Hoffm.

Jatropha macrorhiza is here assigned to sect. *Adenorhopium* on the basis of its tubular corolla, its dissected stipules and its fimbriate caruncle, although it seems to have no close relatives in the genus (in any section) and lacks the characteristic glands of *Adenorhopium*. *Jatropha purpurea* likewise differs markedly from the remaining members of the section, and perhaps should be assigned to a distinct subsection, as Pax proposed. These two species excepted, the section *Adenorhopium* as here delimited is an exceedingly homogeneous one, easily condensed by a not-too-conservative systematist into about four species; more than 30 species, however, have been proposed, more than half of them by Pax or by Pax and Hoffmann. Most of these latter have been based principally upon leaf-, sepal- and indument-characters.

The American species which I should refer to sect. *Adenorhopium* (except *J. macrorhiza* and *J. purpurea*) were assigned by Pax either to his sect. *Glanduliferae* subsection *Adenophorae*, characterized by its glanduliferous petioles in combination with a shrubby habit, or to sect. *Tuberosae*, subsect. *Latifoliae* (plants with herbaceous habit and elliptic unlobed leaves: *J. elliptica* and related species) or subsect. *Macrorrhizae* (plants with herbaceous habit and lobed or unlobed leaves: *J. dissecta* and *J. Isabelli*). These differences seem hardly great enough to constitute the principal bases for intrageneric divisions, but nevertheless amply distinguish small groups of related species.

I have not attempted to distinguish in the above key between *J. elliptica* and its supposed relatives, the types being unavailable and the stated differences between species being almost wholly minor ones. Pax supposed *J. Isabelli* to be closely akin to *J. dissecta*, apparently because of the predominantly herbaceous nature of both species; he proposed *J. induta*, *J. transiens* and *J. brachypoda* as "subspecies" or "formae intermediae," supposing them to be of the nature of hybrids between *J. Isabelli* and *J. dissecta*. A photograph of the type of *J. Isabelli*, however, suggests that it may be most closely related to the group of *J. elliptica*, having normally unlobed leaves, than to the group with deeply parted leaves and short petioles including *J. dissecta*, and specific limits in this latter group must remain to be worked out. Another group of this affinity, that having the leaf-blades shallowly lobed (*J. ribifolia*, etc.), is likewise a Paraguayan assemblage in which specific limits remain to be clarified. The fourth species-group which seems naturally distinct is that including *J. excisa* and probably *J. thyrsantha* and *J. flavovirens;* plants of this affinity seem to be most numerous in northern Argentina and adjacent areas, and are set off from all others by the loose

inflorescence, the mostly simple petiolar glands and (in all specimens I have examined) the 10 stamens. Finally there remain *J. gossypifolia* and the species I take to be its immediate relatives; again final disposition of these must await examination of the types and study of more extensive series of specimens than are now available in this country. *Jatropha clavuligera* is supposedly distinct because of the simple petiolar glands and deeply parted leaves, but other material from the same region (the Bolivian highlands), including the type collection of *Jatropha pedatipartita*, has the same leaf-shape and a similar inflorescence and similar pubescence, but has the petiolar glands both simple and branched on the same leaf. It seems probable that the type of *J. clavuligera* was an aberrant individual which bore simple glands only or which had lost the branched ones before Mueller examined it.

4. Sect. MOZINNA (Ortega) Pax. Natürl. Pflanzenfam. **3**(5) : 75. 1890.

Mozinna Ortega, Pl. Dec. 8: 104, as genus. 27 Ja., 1799; *Curcas*, sect. *Mozinna* (Ortega) Baill. Etud. Gen. Euphorb. 315. 1858.

Shrubs or small trees, monoecious or (often) dioecious; stipules usually very small; staminate inflorescence slender, many-flowered, several times dichotomous; pistillate inflorescence reduced, stout, 1–3-flowered; bracts and sepals of the staminate flowers more or less scarious, usually entire and non-glandular, not herbaceous; sepals of the pistillate flowers larger, usually herbaceous, often toothed or glandular; corolla of both sexes cylindric-urceolate with recurved lobes, the tube usually longer than the lobes, more or less hirsute within at base; stamens regularly 10, the anthers ovate to linear but if slender then relatively short, often 1 mm. long or less; locules of the ovary and primary style-branches (normally 3) often reduced to 2 or 1; primary style-branches once bifurcate, with thickened fungoid stigmas; seed in most species (except the West Indian) globose or nearly so, with a relatively large, flat and irregular hilum and a minute, appressed-recurved caruncle.

TYPE-SPECIES, *Mozinna spathulata* Ortega.

This is primarily a Mexican group, whose distinctness has been recognized by all students of the Euphorbiaceae. Phylogenetically it appears to be old, most of the species exhibiting dioecism, reduction of vegetative tissue and number of carpels, and adaptation to arid conditions. Its nomenclatural history has been somewhat involved, several names having been applied to it and to its subdivisions. The name *Curcas*, first used by Grisebach for the name of a section, is untenable in the sectional category because of the sectional names *Mozinna* and *Eucurcas* previously proposed by Baillon. The latter was used by Mueller for a subsection, but cannot be used for a section of *Jatropha* because of the existence of sect. *Eucurcas* Pax. The section *Mozinna*, as I interpret it, is essentially identical in circumscription with sect. *Curcas* as used by Mueller, and with subgenus *Curcas* of Pax. The group was divided by Mueller into three subsections based chiefly upon the method

of branching of the inflorescence; in this course he was followed closely by Pax; in general I agree with their system except that I should not separate the group of species with reduced inflorescences (referred by them to *Mozinna*) from obviously closely related species on the basis of this single character. I should separate the following subsections:

1. Plants probably chiefly monoecious, or if dioecious the pistillate flowers in stout, long-stalked inflorescences; lowest branch of the inflorescence regularly alternate, with no flower in the axil; corolla yellow to green; seed more or less elongated or flattened, chestnut-brown to black; fruit often (always ?) fleshy, often semi-drupaceous ..... Subsect. *Eucurcas* Muell. Arg.

1. Plants chiefly dioecious or, if monoecious, the pistillate flowers few in the lowest forks of the cymes; pistillate inflorescences reduced, few-flowered, sessile or essentially so; branches of the staminate inflorescence all opposite or subopposite, with a terminal flower in the fork; corolla white to pink or red, (rarely yellow ?); seed usually globular, varying from gray to dull brown; fruit definitely capsular, not fleshy ..... Subsect. *Mozinna* (Ortega) Muell. Arg.

4a. Subsect. EUCURCAS Muell. Arg. in DC. Prodr. **15**(2): 1080. 1866.

Jatropha, sect. *Curcas*, subsect. *Eucurcas* Muell. Arg., l.c.; *Curcas* Adans. Fam. Pl. 2: 356, as to type. 1763; *Castiglionia* R. & P. Fl. Per. 139, as to type. 1794; *Curcas*, sect. *Eucurcas* Baill. Etud. Gen. Euphorb. 314. 1858; *Jatropha*, sect. *Curcas* Griseb. Fl. Br. W. Ind. 36, as to type, 1864; *Jatropha*, subgenus *Curcas* Adans. ex Pax, Natürl. Pflanzenfam. 3(5): 74, as to type. 1890; *Jatropha*, subgen. *Curcas*, sect. *Eucurcas* Pax, l.c.; *Jatropha*, subgen. *Curcas*, sect. *Castiglionia* (R. & P.) Pax, Pflanzenreich IV. **147**: 76. 1910.

TYPE-SPECIES, *Jatropha Curcas* L.

The species in this subsection, other than *J. Curcas*, are so poorly known that they are associated in this manner as a tentative arrangement only. *Jatropha Andrieuxii* and *J. Pseudo-Curcas* have apparently been collected not more than twice or thrice each. Provisionally the three species may be separated as follows:

1. Seeds black, encrusted-striate, 15–22 mm. long; plants glabrous or with more or less flocculent tomentum; inflorescence expanded, loosely flowered, with small bracts; widely cultivated ..... *J. Curcas.*

1. Seeds chestnut-brown to almost black, more or less lustrous, smooth, 10–15 mm. long; plants uniformly and thinly strigulose to pilose or tomentose; inflorescence various ..... 2.

2. Inflorescence expanded, loosely flowered, with small bracts; leaves uniformly and thinly strigulose on both surfaces with sharp whitish hairs; seeds chestnut-brown, 13–15 mm. long, 11–12 mm. wide ..... *J. Pseudo-Curcas.*

2. Inflorescence subcapitate, the bracts and sepals foliaceous, the former up to 4 cm. long; leaves densely pilose above, more or less tomentose beneath; seed lustrous, almost black, 10–12 mm. long, 7–8 mm. wide ..... *J. Andrieuxii.*

1. JATROPHA CURCAS L. Sp. Pl. 1006. 1753.

The original range of *J. Curcas* doubtless included the *tierra caliente* of southern Mexico and Central America, but as it is widely planted and has been so since before the advent of Europeans in the New World, it is not

now possible to say more than this. There are records of its occurrence in the West Indies early in the 16th century, and it may be native there. Morphologically it varies but little; specimens from all parts of its range, in both Hemispheres, are quite uniform in characters. In western Mexico, however, the prevailing form of the species is one differing from the usual type by the development of a considerable amount of flocculent reddish tomentum, especially in the inflorescence; this form appears unquestionably to be indigenous in the region from Colima to central Sinaloa, and occasional individuals from the area between Guerrero and Guatemala approach it in degree of pubescence and may likewise represent a part of the native population of this species. The usual form found in cultivation and as a roadside or dooryard tree is almost glabrous or has a relatively small amount of (usually yellowish) tomentum in the inflorescence.

1a. JATROPHA CURCAS var. **rufus** McVaugh, var. nov. A planta typica foliis junioribus ramis inflorescentiae dense pubescentibus, bracteis calycibusque flocculose rufo-tomentosis, differt. Flores seminaque ut in forma typica.

TYPE collected at Ymala [Imala], Sinaloa, Aug. 16 to 25, 1891, by Edward Palmer (no. 1413); specimen in the United States National Herbarium. Additional specimens examined: SINALOA: Without locality, *J. G. Ortega 7065* in 1933 (F), *7299* in 1934 (F); Mazatlán to Villa Unión, *L. H. McDaniels 14*, Aug. 6, 1935 (F); COLIMA: Colima, *Edw. Palmer 23*, July 1897 (US).

2. JATROPHA PSEUDO-CURCAS Muell. Arg. Linnaea **34**: 208. 1865.

This species is known but from the type collection, made by Liebmann in Oaxaca, from Barrancea de Panoaya, Veracruz (*Purpus 8816*, CAL), and from a collection (*G. B. Hinton 4300*) made between Salitre and Cañitas, Temascaltepec, E. de México, July 10, 1933. It much resembles *J. Curcas* but may be distinguished from that species by the thin reddish-yellow tomentum of the inflorescence, by the pubescence of the leaves and by the seeds. The fruit is unknown to me. Hinton notes that the flowers are white, and that the vernacular name is "Piñoncillo." Mueller states that the style-column is longer than the stigmas, in contrast to *J. Curcas* in which he states the reverse to be true; I have not been able to confirm this difference, finding the column short in both species, although with some individual variation.

3. JATROPHA ANDRIEUXII Muell. Arg. Linnaea **34**: 208. 1865.

This plant is of rather doubtful affinity, having been placed by Mueller in *Adenorhopium* because of the supposedly distinct petals, but evidently akin to *J. Curcas* and other species of the section *Mozinna* in the large dark seeds with small caruncle, the very large foliaceous calyx-lobes of the pistillate flowers, the small stipules, the leaves similar to those of *J. Curcas* and *J. Pseudo-Curcas*, the 10 stamens, and the plant-habit; the corolla-lobes,

instead of being free as stated by Mueller, are (at least in the pistillate flower) connate up to half their length. The species differs from all other species known to me, however, in the long-stalked, sub-capitate (pistillate) inflorescence with leafy bracts surpassing and concealing flowers and fruits; the styles, moreover, are bifurcate but slender, apparently lacking the fleshy stigmatic lobes characteristic of *Mozinna*, and the corolla (pistillate) is entirely glabrous. I have seen no staminate flowers, but Mueller's description supplies most of the characters usually found in the section; he says that the teeth of the staminate calyx are entire, 3–4 mm. long (i.e. much smaller than the pistillate), the petals villous within, the filaments 10.

The species is known but from the original collection, made by Andrieux (no. 114) between Chila, Puebla, and Huahuapan, Oaxaca, and from a collection made by Pringle near Iguala, Guerrero, Oct. 24, 1900. The foliage resembles that of *J. Curcas*, but the leaves are uniformly and densely soft-pilose on both surfaces, and the petioles are relatively short and stout (2 mm. in diameter, mostly 2–5 cm. long) and tomentose. The bracts of the inflorescence are undulate and often lobulate, up to 2 cm. wide and 3–4 cm. long; the sepals (pistillate) are often half as large. The capsule is ovoid, pointed, 13–15 mm. long and wide, apparently somewhat fleshy and tardily dehiscent; the seed is lustrous, almost black, 10–12 mm. long, 7–8 mm. wide, 5–6 mm. thick.

4b. Subsect. MOZINNA (Ortega) Muell. Arg. in DC. Prodr. **15**(2): 1081. 1866.

Jatropha, sect. *Curcas*, subsect. *Mozinna* Muell. Arg., l.c., as to type; *Mozinna* Ortega, Dec. Pl. 8: 104, as to type. 27 Ja., 1799; *Loureira* Cav. Ic. 5: 17. [late] 1799; *Curcas*, sect. *Mozinna* (Ortega) Baill. Etud. Gen. Euphorb. 315. 1858; *Jatropha*, sect. *Curcas*, subsect. *Loureira* (Cav.) Muell. Arg., op. cit. 1076; *Zimapania* Engl. & Pax, Natürl. Pflanzenfam. 3(5): 119, 1891; *Jatropha*, subgenus, *Curcas*, sect. *Loureira* (Cav.) Muell. Arg. ex Pax, Pflanzenreich IV. 147: 74. 1910; sect. *Mozinna*, subsect. *Brachyblastae* Pax, op. cit. 81, in clavi; subsect. *Canescentes* Pax, l.c.

TYPE-SPECIES, *Mozinna spathulata* Ortega.

There are about 20 known species of this subsection; most of them are well marked and easily recognized, but not more than half of them are well known, the others having been collected not more than a few times each. The characters used by Mueller and Pax to divide the group seem to produce an unnatural arrangement, and I am at a loss to effect any division within the subsection unless *J. Gaumeri*, an endemic of the Yucatan peninsula, be removed entirely from the section *Mozinna* on the bases of its uniquely divided styles. *J. fremontioides*, known only from the original collection in southern Oaxaca, is likewise unique in its congested and capitate inflorescence with imbricate paleaceous bracts, and its large fimbriate caruncle suggests no relationship to *Mozinna*, but its flowers are those of that section and apparently it must be placed therein unless a new group be established for it. The dioecious members of the subsection have for the most part seeds

which are characterized by their nearly globular shape and their very small caruncles, while the monoecious members, including *J. Gaumeri*, *J. fremontioides* and the two West Indian species, *J. divaricata* and *J. hernandiaefolia* have seeds more nearly like those of *Adenorhopium*. Seeds of several species are unknown to me, however, and it seems unwise to make any further attempt at classification based upon this single character.

The remaining members of the subsection agree to a remarkable degree in reproductive characters, especially when one considers the rather excessive variation which they exhibit in vegetative structure, and on this account it seems unnecessary to designate any formal series or other categories, although two such series are superficially apparent. The first of these includes *J. cuneata*, *J. dioica*, *J. neopauciflora*, and perhaps others, and is characterized by the narrow, cuneate, and almost sessile leaves of the included species; the other series includes species with broader, ovate or cordate leaves with slender petioles. The gap between the series is bridged by such species as *J. sympetala*, *J. Standleyi*, *J. Ortegae*, and *J. Riojae*, as far as leaf-characters are involved. The members of the first series often have the inflorescences so reduced as to appear fasciculate, but varying degrees of reduction are found in individual plants, and similar conditions may be found in *J. cinerea* and other species, so that a more or less continuous intergrading series can be established from species with few-flowered and much reduced cymes to those with much branched many-flowered types. Any attempt to subdivide the subsection along these lines would seem to be a purely arbitrary one.

The following purely artificial key will serve to distinguish the species:

1. Leaves broadly peltate ..... 2.
   2. Plants monoecious; leaves up to about 12 cm. long, ovate, unlobed or 3-lobed, mostly abruptly and sharply acuminate; Puerto Rico and Hispaniola ..... *J. hernandiaefolia.*
   2. Plants dioecious; leaves mostly 18–30 cm. long, orbicular-ovate, usually with 3 or 5 rounded lobes; Sinaloa to Michoacán ..... *J. platyphylla.*

1. Leaves not peltate (or in exceptional individuals the basal margins of the blade produced into a narrow wing 1–2 mm. wide) ..... 3.
   3. Inflorescence capituliform, monoecious, the staminate flowers sessile and the bracts closely imbricate; Oaxaca ..... *J. fremontioides.*
   3. Inflorescences not capituliform, usually dioecious or, if monoecious, the staminate flowers pedicellate in slender cymes ..... 4.
      4. Plants monoecious, glabrous, with entire, ovate, acuminate leaves ..... 5.
         5. Style-branches flattened, incised-toothed, stamens 8; Yucatan Peninsula ..... *J. Gaumeri.*
         5. Style-branches slender, with thickened fleshy stigmas; stamens (?8–)10; Jamaica ..... *J. divaricata.*
      4. Plants mostly dioecious, variously pubescent or glandular; style-branches filiform with capitate or somewhat elongate fleshy stigmas; leaves various; southern and western Mexico ..... 6.

6. Leaves cuneate, relatively narrow (those on shoots sometimes pinnately lobed); petioles normally short (5–10 mm. long or less, or sometimes longer on vigorous shoots), the leaves mostly appearing sessile or nearly so ..... 7.

7. Leaves green and glabrous or nearly so above, persistently and prominently whitened and waxy-papillose beneath ..... *J. sympetala.*

7. Leaves either glabrous or pilose, never whitened and papillose ..... 8.

8. Stipules 5–8 mm. long, covered at least at base with bright ferrugineous hairs; leaves pilose and somewhat whitened on both surfaces; staminate corolla 6–9(12) mm. long; anthers 1.3–1.7 mm. long ..... *J. neopauciflora.*

8. Stipules 1–1.5 mm. long or less (rarely 3.5 mm.), canescent at base with pale hairs; leaves essentially glabrous on both surfaces at maturity; staminate corolla 4–7 mm. long; anthers 1 mm. long or less ..... 9.

9. Leaf-blades entire, 2–3 times as long as wide, with one pair of lateral veins in addition to the basal pair; staminate cymes evidently branched, slender, 0.7–1.5 cm. long; bracts and sepals ciliate on tips and margins; intricately branched shrubs of the Sonoran Desert, with hard woody twigs ..... *J. cuneata.*

9. Leaf-blades often 3-lobed on vigorous shoots, mostly much more than 3 times as long as wide, with two pairs of lateral veins in addition to the basal pair; staminate cymes greatly reduced, the flowers apparently in dense terminal or axillary clusters; bracts and sepals rather uniformly pubescent, often canescent; sparingly branched shrubs, Texas and eastern Mexico, with parenchymatous twigs that shrink conspicuously upon drying ..... 10.

10. Leaf-blades 2.5–6 times as long as wide, mostly 6–10 mm. wide ..... *J. dioica* var. *sessiliflora.*

10. Leaf-blades 6–17 times as long as wide, mostly 1–4 mm. wide ..... *J. dioica* var. *graminea.*

6. Leaves relatively broad, often more or less cordate, varying to oblong or oval or, if narrow, then with conspicuous slender petioles ..... 11.

11. Mature blades up to 10–12 cm. long and wide, densely rufous-tomentose beneath over the entire surface ..... 12.

12. Blades cordate, broadly ovate, entire or with blunt shallow lobes; Puebla and Oaxaca ..... *J. rufescens.*

12. (Mature blades unknown, but probably densely pilose or tomentose, with 3–5 ovate, long acuminate lobes; Sonora. *J. malacophylla*).

11. Blades mostly smaller, either glabrous, glandular or variously pubescent, but the mature blades not rufous-tomentose (sometimes cinereous-tomentose in *J. cinerea*) ..... 13.

13. Blades not lobed, ovate, oval or oblong, cuneate to rounded at base, not cordate, pinnately veined (the lowest pair of veins often larger than the others) ..... 14.

14. (Petioles puberulent; blades usually cinereous-tomentellous and rounded or truncate at base, suggesting the cordate condition; Sinaloa, Sonora, Baja California ..... exceptional forms of *J. cinerea*).

14. Petioles glabrous; blades cuneate or rounded at base, glabrous or nearly so ..... 15.

15. Blades with several cupuliform glands on the margins near base ..... 16.

16. Petioles very slender; lower surface of blades very minutely puberulent; Sinaloa ..... *J. Ortegae.*

16. Petioles stout (to 2 mm. in diameter); blades glabrous; Oaxaca ..... *J. Standleyi.*

15. Blades entire, glabrous; Puebla (see also forms of *J. sympetala*, which may have the blades almost without the normal covering of white papillae) ..... *J. Riojae.*

13. Blades often lobed, usually definitely cordate at base, ovate to reniform, palmately veined at base (at least in leaves with lobes) ..... 17.

17. Blades with 3–5 sharp lobes, these ovate-deltoid with acuminate tips ..... 18.

18. Blades not glandular, densely velutinous-pilose (mature blades unknown); Sonora and Sinaloa *J. malacophylla.*

18. Blades more or less beset with cupuliform ("pinhead") glands at least on the basal lobes; pubescence of blades more or less confined to the veins and margins; southern Mexico ..... 19.

19. Leaves more or less glaucous, with soft, usually bright red, hairs; inflorescence glabrous except the bracts, which are red-hirsute within; México to Oaxaca ..... *J. ciliata.*

19. Leaves not glaucous, stiff-puberulent, the hairs usually whitish; inflorescence canescent; Oaxaca ..... *J. Alamani.*

17. Blades entire to shallowly lobed or toothed ..... 20.

20. Blades irregularly crenulate, the crenulations at least when young with sessile glands ..... 21.

21. Plants entirely glabrous; blades mostly 3 cm. long and wide, or less, often wider than long, abruptly and prominently blunt-acuminate; Arizona and Sonora ..... *J. cardiophylla.*

21. Inflorescence cinereous-tomentellous, glabrescent; plants otherwise glabrous; blades often 5–8 cm. long, ovate, longer than wide, acute or short-acuminate; southern Baja California ..... *J. vernicosa.*

20. Blades entire to toothed or lobed; foliar glands, if present, stalked ..... 22.

22. Leaves, inflorescences and twigs more or less cinereous-tomentellous; blades usually not glandular or lobed but rarely one or both; northwestern Mexico ..... *J. cinerea.*

22. Plants not cinereous-tomentellous; blades usually with stalked glands ..... 23.

23. Blades unlobed, ovate, 3–6 cm. wide, green, the margins rather densely beset with stalked glands; bracts of the staminate inflorescence ciliate and hispidulous on backs; Jalisco to Sonora ..... *J. cordata.*

23. Blades often somewhat lobed, at maturity 10–15 cm. wide, usually glaucous, sparingly glandular; bracts red-hirsute within; México to Oaxaca ..... *J. ciliata.*

Jatropha Alamani Muell. Arg. is known only from the vicinity of Tehuantepec, Oaxaca, where collected by Alaman in 1832 (TYPE in herb. DC., Field Mus. neg. 7161!) and by Orcutt (no. *5329!*) in 1910. I have not seen pistillate material, and the fruits and seeds are unknown.

J. canescens (Benth.) Muell. Arg. is to be relegated to the synonymy of *J. cinerea* (Ortega) Muell. Arg., a characteristic shrub of the areas adjacent to the Gulf of California. *Jatropha cinerea* consists of several races distinguished by leaf-shape and quality of pubescence; the principal ones are as follows:

1. A race localized near the tip of the peninsula of Baja California. The leaf-blades are large for the species, 5–8 (10) cm. wide and long, mostly cordate with rounded basal lobes, the midrib 4–6 (7) cm. long, the basal pair of veins often spreading at an angle of 180° or somewhat reflexed. The blade is usually pointed, its tip acute to acuminate or rounded, the lower surface thinly tomentose and whitened, the upper surface and the petiole sparsely puberulent. The branches appear to be stouter than in other races. I have seen 10 collections of this race, which is known as "lumboi" (Bailey) or "lomboy" (Collins et al.). A collection from Guamuchil, Sinaloa, *Shreve 6391*, is similar to Baja California material.

2. A rather restricted race found, in its most typical form, along the northern coast of Sonora about Kino Bay, and on the gulf coast of Baja California south about to latitude 26°. The leaf-blades are (2)2.5–4(or 6) cm. wide and long, mostly rounded or reniform, often folded on herbarium sheets, rounded or truncate or obscurely cordate at base, the basal lobes, if any, rarely extending below the base of the veins, the midrib thus the longest part of the blade; basal pair of veins often undeveloped, (veins then one pair only in addition to the midrib), but if present usually evidently ascending. Blade usually rounded at tip but sometimes obtusely pointed; pubescence sparse, and sometimes entirely wanting from mature leaves. I should refer to this race 7 collections from Sonora, one from Sinaloa (San Blas, *M. E. Jones 23327* in the Field Museum) and one from Baja California (Loreto, *Jones 27547*).

3. Apparently the most common race, from northern Sonora (or southern Arizona) to central Sinaloa. I have seen 15 collections of this, distinguished from no. 2 by the rather dense and generally distributed pubescence, which makes the young growth and the inflorescence felty-white; the leaves are essentially like those of no. 2, but are usually permanently and densely tomentose beneath and on the petioles, but sparsely pubescent above. The blades are sometimes sparsely glandular-toothed or divided into three broad rounded or truncate lobes, especially on vigorous shoots. A collection from "Quitobaquita," made by Schott in August 1855, now in the Field Museum, may have been taken in what is now Arizona, and if so represents the first definite record of this species from the United States.

4. A specimen collected at Magdalena Island, Baja California, by T. S. Brandegee, Jan. 12, 1889, has the leaves tomentose on both surfaces; this apparently represents typical *Mozinna canescens* Benth., also first collected on Magdalena Island.

Jatropha cordata (Ortega) Muell. Arg. is relatively common from central Sonora to northern Sinaloa and extends sparingly south to Jalisco. In this species pubescence is apparently somewhat correlated with geographic distribution; all material from Sonora and Chihuahua is glabrous or essentially so, but all from Jalisco and most from Sinaloa (except from the extreme north) is rather densely stiff-pubescent. A collection from southern Zacatecas, *Rose 2415*, is glabrous. A fragment in the Field Museum herbarium, probably from the type plant of *Loureira glandulosa* Cav., is the pubescent form, as in no. 4245 of the collection made by Sessé, Mociño and Maldonado; presumably Ortega's original *Mozinna cordata* was of the same type.

Jatropha dioica Sessé in Cerv. As pointed out elsewhere (MeVaugh, 1945, this name must replace the well known *J. spathulata* (Ortega) Muell. Arg.

The type of *Jatropha malacophylla* Standl. (the only collection so far distributed under this name) is apparently conspecific with all material distributed as *J. platanifolia* Standl. (including the type). The species discussed by Gentry in his *Rio Mayo Plants* (Carneg. Inst. Wash. Publ. 527: 166, etc. 1942) under the name of *J. platanifolia* should therefore be called *J. malacophylla*. The type of *J. malacophylla* differs from that of *J. platanifolia* in having ciliate but otherwise nearly glabrous sepals in the staminate flowers; the sepals of *J. platanifolia* vary from very nearly glabrous to rather densely hirsute. In addition, the leaves of the type of *J. malacophylla* (an immature specimen) are predominantly 3-lobed, with young 5-lobed leaves just beginning to appear, while most leaves of the type and other specimens of *J. platanifolia* (even when immature) are 5-lobed. In view of the exact correspondence in other respects between the two "species," the above differences appear to represent individual variations rather than more fundamental ones.

J. neopauciflora Pax is known only from a small area in the vicinity of Tehuacán, in southern Puebla. Here is probably to be referred *J. Harmsiana* Mattf., based on a collection made by J. A. Purpus in April 1922, in "Kalkberge bei Telmacan." This collection was in the Berlin herbarium and presumably, has been destroyed. The type-locality is given as Tehuacán by Pax (Pflanzenreich IV. **147.** XVII: 204. 1924).

J. Ortegae Standl. is known to me only from the type collection and from another (*J. G. Ortega 7413*) from the same region, southern Sinaloa. It is evidently very closely related to *J. cordata*, and also to *J. Riojae* Miranda, of Puebla.

J. Standleyi Steyermark appears to be a very much localized species of southern Oaxaca. It is known only from the type, collected by Matuda at Tehuantepec in 1936, and from a living tree in the collection of the Missouri Botanical Garden, thought to have come from material collected by C. R. Orcutt at Tehuantepec in 1910. A specimen in the Field Museum, collected in "Mexico" in 1791 by Haenke, appears to be of this species. The type of *J. Standleyi* is in the herbarium of the University of Michigan, as noted by Lundell (1941), not at the Field Museum as stated in the original description.

The type of *Jatropha sympetala* Standl. & Blake (from Playa de Coyula, Oaxaca, *Reko 350!*) has entire oval leaf-blades up to 5 cm. wide and 8 cm. long, on slender petioles up to 1.5 cm. long; the lower surface is pale and densely papillose, but not strongly whitened. It suggests on the one hand a relationship with *J. Riojae* Miranda, which has similarly shaped but smaller and greener leaves, and on the other a relationship with *J. Ortegae* Standl., which has pubescent blades of similar shape but with glandular margins. I should refer no other specimens to *J. sympetala* except the following, in both of which the lower surfaces of the leaves are much more conspicuously whitened than in the type: Tehuantepec, Oaxaca, *Orcutt 5259;* Mazatlán, Sinaloa, *Rose 1388*. The Orcutt specimen differs from the others in having glandular margins on some of the leaves, and both Orcutt's and Rose's specimens differ from the type in the more elongate and cuneate short-petiolate leaves, which in shape suggest those of *J. dioica*.

Jatropha vernicosa Brandg. appears to be a distinct species endemic in the relatively mesophytic habitat of canyons of the higher mountains of southern Baja California. Standley (1923) says "Rather doubtfully distinct from *J. cordata*," but the affinities of *J. vernicosa* seem to be as much with *J. cardiophylla* as with *J. cordata*. It is easily distinguished from the latter by its lack of stipitate glands. The following specimens are referred here: Corral Piedra, *T. S. Brandegee*, Sept. 9, 1893 (Type, CAL; GH); Sierra de San Francisquito, *Brandegee 545*, Oct. 20, 1890 (CAL); Arroyo Hondo, Sierra Giganta, *Gentry 4150* (Mo).

DOUBTFUL ENTITIES

Sect. *Stigmatosae* Pax & Hoffm. Pflanzenreich IV. **147.** XVII: 192. 1924. This was assigned to subgenus *Adenoropium*, apparently on the basis of habital resemblance to species of sect. *Tuberosae*. The description of *J. stigmatosa*, the only species of the section, suggests a *Ditaxis* but I have not seen the type. The section was based principally upon the character of the filiform, radiating styles.

Jatropha catingae Ule and *J. palmatifolia* Ule I cannot place from the descriptions. Both are said to have 6 stamens and the leaf-margins entire and eglandular, and there is nothing else like this known in the genus.

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[*Polymorphae*, I; *Macranthae*, II; *Adenorhopium*, III; *Mozinna*, IV. Names considered to represent synonyms are italicized and followed by what is most probably the correct specific name, inclosed in brackets. A brief basis for the assignment of each species to a section or to synonymy is given in parentheses. In addition to the specimens cited below, I have examined all the material of *Jatropha* in the following herbaria: United States National Herbarium, Herbarium of the National Arboretum and the herbarium of the Missouri Botanical Garden. Certain material, chiefly Mexican, has been examined from the following sources: Arnold Arboretum, Gray Herbarium, Chicago Museum of Natural History (cited herein, as always previously, as the Field Museum), New York Botanical Garden, University of Michigan, University of California at Berkeley. To those in charge of these herbaria I am grateful for many kindnesses. Mr. Paul C. Standley is especially to be thanked for his efforts in assembling for me all the specimens of *Jatropha* from the herbarium of Sessé and Mociño.]

acerifolia Salisb. [Curcas] (fide Ind. Kew.)
acuminata Desr. [integerrima] (Description)
Alamani Muell. Arg., IV (FM neg. 7161!)[3]
Andrieuxii Muell. Arg., IV (FM neg. 32488!)
angustifolia Griseb., I (Description)
antisiphilitica Speg. [?Isabelli] (Pax, 1910; Lourteig & O'Donell, 1943)
arizonica I.M. Johnst. [macrorhiza var. septemfida] (Type, GH!)
Augusti Pax & Hoffm., II (?Phototype, FM neg. 5379!)
Berlandieri Torr. [cathartica] (Type, NY!)
Berterii Spreng. [unknown]
Bornmülleri Pax, III (Description)
brachypoda Pax, III (Description)
breviloba (Morong) Pax & Hoffm., III (Isotype, US!)
cancescens (Benth.) Muell. Arg. [cinerea] (Voy. Sulph. pl. 25)
cardiophylla (Torr.) Muell. Arg., IV (type, NY!)
cathartica Ter. & Berl., II (Description)
catingae Ule [doubtful; see above]
cercidiphylla Standl. [not Jatropha] (Contr. U. S. Nat. Herb. 23: 1669)
ciliata Sessé, IV (Type, Madrid!)[4]
ciliata Muell. Arg., II (FM neg. 24382!)[5]

[3] The "phototypes" from the series assembled by the Field Museum are designated by negative number as in this case; in this table I have not distinguished between photographs of actual types and those of isotypes (for example, neg. 24388, *J. macrorhiza*); when the photograph is not certainly of type material, I have indicated this by a question-mark preceding the word "phototype."

[4] The types of species of *Jatropha* described by Sessé or in the posthumous works of Sessé and Mociño must of necessity be arbitrarily chosen—lectotypes. Often there are in the herbarium of Sessé, Mociño and Maldonado several mounted sheets of the same species, bearing the same name and number. In such cases I have selected as type, whenever possible, the best sheet from among those not accessioned by the Field Museum; these are cited in this table as having been seen in the Madrid herbarium, although all are now on deposit in Chicago. In some cases (e.g. *Jatropha dioica* and *J. edulis*) I have seen only the sheets of these species accessioned by the Field Museum; these are mentioned in the table with the designation "type-collection."

[5] The specimen photographed under this number is from the Delessert Herbarium, collected by Pavon (no. 108), supposedly in Mexico. It was determined by Mueller as *J. ciliata*, and is without doubt the Peruvian plant currently passing as *J. ciliata* Muell. Arg. The type of this species, however, was collected "in Peruvia prope Huanaca," and

cinerea (Ortega) Muell. Arg., IV (Description)
clavuligera Muell. Arg., III (FM neg. 7160!)
coccinea Hort. ex Steud. [?integerrima]
coccinea Hort. ex Link [integerrima] (Pax, 1910)
cordata (Ortega) Muell. Arg., IV (Description)
cuneata Wiggins & Rollins, IV (Isotype, AA!)
cuneifolia Sessé & Moc. [unknown; said to be from Puerto Rico]
Curcas L., IV (Description)
decipiens M. E. Jones [not Jatropha] (C. V. Morton in Contr. U. S. Nat. Herb. 23(2), in press)
dioica Sessé, IV (Type collection, F!)
dissecta (Chod. & Hassl.) Pax, III (Description)
divaricata Sw., IV (Description)
divergens (Pohl) Baill. [mollissima] (fide Muell. Arg., 1866)
diversifolia A. Rich. [integerrima] (Description)
edulis Sessé [Curcas] (Type-collection, F!)
eglandulosa Pax, III (FM neg. 5384!)
elegans (Pohl) Klotzsch [gossypifolia] (Description)
elliptica (Pohl) Muell. Arg., III (Pohl, Pl. Bras. Ic. 1: *pl. 9*)
excisa Griseb., III (FM neg. 5385!)
flabellifolia Pax & Hoffm. [Paxii] (Jour. Arn. Arb. 24: 168)
flavovirens Pax & Hoffm., III (FM neg. 5386!)
fremontioides Standl., IV (Type, F!)
Gaumeri Greenm., IV (Type, F!)
glauca Griseb. [angustifolia] (Muell. Arg., 1866, p. 1093)
glaucovirens Pax & Hoffm. [integerrima] (Isotype, Mo!)
gossypifolia L., III (Description)
grandifrons I. M. Johnst. [ciliata Sessé] (Type, GH!)
grossidentata Pax & Hoffm., II (?Phototype, FM neg. 5387!)
guaranitica Speg., III (Description)
Harmsiana Mattf. [neopauciflora] (Description)
hastata Jacq. [integerrima] (Jacq. Sel. Stirp. Am. 256, *pl. 183, f. 47*, *pl. 173, f. 54*)
hernandiaefolia Vent., IV (Description)
heterophylla Sessé & Moc. [hernandiaefolia] (Type, Madrid!)
Hieronymi Kuntze, II (?Phototype, FM neg. 5390!)
hippocastanifolia Croiz., III (Description)
Hoffmanniae Croiz., II (Description)
Humboldtiana McVaugh, II (Description)
induta (Chod. & Hassl.) Pax, III (FM neg. 24384!)
integerrima Jacq., I (Description)
intercedens Pax, III (FM neg. 5393!)
intermedia (Chod. & Hassl.) Pax, III (Description)
Isabelli Muell. Arg., III (FM neg. 24385!)
Jacquini (Pohl) Baill. [gossypifolia] (Mueller, 1866; Pax, 1910)
Katharinae Pax, III (Pax, 1910, fig. 8)
Lacerti Silva Manso [elliptica] (fide Pax, 1910, p. 62)
Loeflingii Aresch. [unknown]
longipedunculata Pax & Hoffm. [Hoffmanniae] (Jour. Arn. Arb. 24: 168)
luxurians (Pohl) Baill. [mollissima] (Muell. Arg., 1866, p. 1091)
macrantha Muell. Arg., II (FM neg. 8496!)
macrocarpa Griseb., II (FM neg. 5394!)
macrorhiza Benth., III (FM neg. 24388!)
var. septemfida Engelm., III (Isotype, US!)
malacophylla Standl., IV (Type, US!)
Malmeana Pax & Hoffm., III (Description)
Martiusii (Pohl) Baill., II (Description)
minor Urb., I (Description)
mitis Sessé & Moc. [unknown]
mollissima (Pohl) Baill., II (Description)
moluensis Sessé & Moc. [integerrima] (type, Madrid!)
multifida L., II (Description)
multiflora Pax & Hoffm. [macrocarpa] (Lourteig & O'Donell, 1943)
mutabilis (Pohl) Baill., II (Description)
neopauciflora Pax, IV (Contr. U. S. Nat. Herb. 12: pl. 22)
nudicaulis Benth., II (Description)
officinalis "Mart." [elliptica] (Pax, 1910)
olivacea Muell. Arg. [ciliata Sessé] (Description)
opifera Mart. [elliptica] (fide Pax, 1910)
Ortegae Standl., IV (Type, F!)
pachypoda Pax, II (FM neg. 5396!)
palmatifolia Ule [doubtful; see above] (FM neg. 5397!)

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was cited by Mueller as follows: "(Dombey ! Ruiz ! in hb. Mus. paris. et berol.)" (Linnaea 34: 210), so that the Pavon specimen, while conceivably part of the type-collection, certainly is not the type.

palustris Sessé & Moc. [unknown]
panduraefolia Andr. [integerrima] (Andr. Bot. Repos. **4**: *pl. 267*)
papyrifera Pax & Hoffm., II (Description)
pauciflora Griseb. [?integerrima] (Isotype, US!)
pauciflora (Rose) Pax [neopauciflora] (Type, US!)
Paxii Croiz., I (Pax, 1910, fig. 20)
pedatipartita Kuntze, III (Isotype, US!)
Peiranoi Lourt. & O'Don., III (Lilloa **9**: 135, *fig. 17*, *pl. 14*)
peltata Sessé [unknown] (Bull. Torrey Club **72**: 34. 1945)
peltata HBK. [Humboldtiana] (Bull. Torrey Club **72**: 35. 1945)
platanifolia Standl. [malacophylla] (Type F!)
platyphylla Muell. Arg., IV (FM neg. 34049!)
podagrica Hook., II (Bot. Mag. *pl. 4376*)
Pohliana Muell. Arg. [mollissima] (See above)
portoricensis Millsp. [hernandiaefolia] (Description)
Pseudo-Cureas Muell. Arg., IV (FM neg. 21554!)
puncticulata Pax & Hoffm., III (Description)
purpurea Rose, III (Type, US!)
purpurea Rose & Pax ex Pax [purpurea Rose, which is based on same type]
ribifolia (Pohl) Baill., III (Description)
ricinifolia Pax, II (Pax, 1910, fig. 11)
rigidifolia Pax & Hoffm., III (Description)
Riojae Miranda, IV (Isotype, F!)
Robertii S. Moore, II (Description)
rufescens Brandg., IV (Isotype, GH! F!)
spathulata (Ortega) Muell. Arg. [dioica] (Orteg. Pl. Dec. *pl. 13*)
Standleyi Steyerm., IV (Type, MICH!)
staphysagrifolia Mill. [gossypifolia] (Description)
stigmatosa Pax & Hoffm. [unknown; see note above]
sympetala Standl. & Blake, IV (Type, US!)
tacumbensis Pax & Hoffm., III (Description)
thyrsantha Pax & Hoffm., III (FM neg. 5403!)
transiens Pax, III (FM neg. 24390!)
tupifolia Griseb., I (Description)
vernicosa Brandg., IV (Type, CAL!)
villosa (Pohl) Baill. [mollissima] (Muell. Arg., 1866)
Weberbaueri Pax & Hoffm., II (Pax, 1910, fig. 16)
Weddelliana Baill., II (Description)
yucatanensis Briq. [Cureas] (FM neg. 24393!)

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A REPORT OF SOME RECENT COLLECTIONS OF RUBIACEAE FROM ECUADOR

WILLIAM CAMPBELL STEERE

One of the outstanding publications concerned with the botany of the republic of Ecuador has been Paul C. Standley's "The Rubiaceae of Ecuador" (1931), into which he incorporated all available data on this family, and reviewed the classic collections of Richard Spruce and William Jameson. Since 1931 relatively little has been added to our knowledge of the Rubiaceae of Ecuador, although Diels (1937) was able to augment the list with several species, and Acosta-Solís (1943) has recently added a few more.

During 1943 and 1944 large collections of Rubiaceae have been made throughout Ecuador by several botanists engaged in a search for *Cinchona* in behalf of the Office of Foreign Economic Administration (formerly Board of Economic Warfare), a procurement agency of the United States Government. As Senior Botanist and Assistant Director of the Cinchona Mission in Ecuador from July 1943 to September 1944, I had an unexcelled opportunity to collect and study *Cinchona* allies as an integral part of my work.

My chief collecting activity was in the northernmost provinces, Carchi, Imbabura, and Napo-Pastaza, which were well explored; but smaller collections were made in the provinces of Pichincha and León. Moreover, a large collection was made jointly with Dr. W. H. Camp in the valley of the Río Pastaza between altitudes of 3000 and 7500 feet. Although I made several visits to the classical *Cinchona* localities of Loja and Azuay, these visits were unfortunately rapid inspection trips on which there was no time for collecting. The policy of collecting all Rubiaceae has been followed by all the botanists who came later to Ecuador to work for the Cinchona Mission, in order not to overlook any possible sources of quinine, and important collections have already been made by Dr. W. H. Camp, Dr. Ira L. Wiggins, Dr. William B. Drew, Dr. Gerald W. Prescott, and Dr. F. Marion Ownbey.

In such work as that of the Cinchona Mission it was impossible to give attention to the whole of an unfamiliar flora and vegetation. In a futile attempt to understand the ecological relations of a single genus the botanist might attempt to encompass the whole flora, and be baffled by its complexity, finally failing to accomplish or neglecting his basic objective. It was more practicable and much easier to cultivate an alertness in detecting only members of the family to which *Cinchona* belongs. This is exactly the procedure which I developed in my explorations for *Cinchona*. By observing, collecting and studying all Rubiaceae seen in the forests through which I passed,

the possibility of overlooking an unfamiliar or anomalous species of *Cinchona* was automatically avoided.

The practical value of this specialization was demonstrated many times by the discovery of species of *Cinchona* in areas reputedly barren of it. For example, the region of the valley of the Río Pastaza at its junction with the Río Topo has produced many tons of high grade bark during 1943 and 1944, from a form of *Cinchona officinalis* unknown there before our explorations. Richard Spruce spent considerable time in exactly this zone, and the point called "Casha-urcu," which was mentioned in his *Travels* (**2**: 147), has been one of our highest-yielding areas. Also, *Cinchona officinalis* was found to occur throughout Ecuador along the eastern slope of the Andes, even in the northernmost part, instead of being restricted to Loja and Azuay, as believed previously. Furthermore, in Ecuador the members of the Rubiaceae tend to occur in groups, rather than to have a random distribution through the forest, so that when a zone rich in Rubiaceae is discovered, it may at once be suspected to contain *Cinchona*. Consequently, our careful scrutiny of the forest for all members of the Rubiaceae has had the double virtue that no *Cinchona* could be overlooked amid the complex vegetation, and that the discovery of zones rich in Rubiaceae immediately led to a more intensive search for species of *Cinchona*.

As a result of my special attention to the Rubiaceae during my field work in Ecuador between July, 1943, and September, 1944, I was able to collect 345 numbers, which with very few exceptions belong to the Rubiaceae. In order to know while still in the field the Ecuadorean genera and to determine what genera and species of Rubiaceae might characteristically occur in association with the different species of *Cinchona*, specimens were sent by air express from Ecuador to Dr. Paul C. Standley of the Chicago Natural History Museum for identification. The prompt naming of my collections by the outstanding specialist on Rubiaceae (1930, 1931, 1931a, 1931b, 1936), has been of the utmost value. One of the most practical results of his identification for me of several specimens of *Cephaëlis Jamesonii* collected in the *Cinchona pitayensis* zones of the northernmost provinces, Carchi and Imbabura, was that it made possible the discovery of *C. pitayensis* on the west side of the Volcán de Pichincha, in the latitude of Quito, and its first known occurrence south of the equator. The association of *Cinchona pitayensis* with *Cephaëlis Jamesonii*, and the usefulness of the latter as an indicator, has already been reported upon (Steere 1944).

Dr. Standley has identified all my material and at the same time has checked or corrected the identifications which I was able to make through the use of his "Rubiaceae," a copy of which was my constant companion in the field. The statistics of my collection (56 new species out of 345 collection numbers representing about 150 species in all) illustrate graphically the

incredible richness in Rubiaceae of the Ecuadorian flora, and I am convinced from my own observations that intensive work in any other family of plants would have had equally profitable results. A general collector working in a flora as rich as that of the eastern slopes of the Andes in Ecuador is much less apt to get as large a proportion of new and interesting species as the botanist who works more or less exclusively with a single large family or with several smaller, closely-related ones. It is difficult to remain "sensitized" to several groups at the same time. For example, I found that while I was engrossed in a search for *Cinchona* in particular and the Rubiaceae in general, I was almost blind to the presence of other plants in which I have a special interest. Also, of course, a person specializing in one or a few families will have a much better idea of specific and generic concepts and their distinguishing characters. In fact, a general collector who visits the Oriente of Ecuador during the flowering season is apt to be discouraged by the great profusion of species, because he cannot collect them all in the time at his disposal, and is likely to get mainly the most conspicuous and least interesting ones. Spruce (Travels **2**: 207–208) estimated in 1858 that by moving a degree of latitude or longitude, he found about half the plants different. On this basis he calculated that there yet remained to be discovered in the great Amazonian forest "from the Cataracts of the Orinoco to the mountains of Matto Grosso," some 50,000 or even 80,000 new species. This estimate is overwhelming, yet Spruce's experience was more extensive than that of any other botanist before or since, and his judgment in systematic matters has proved to be excellent, more conservative than otherwise. Consequently, where the Amazonian forest impinges upon the eastern flank of the Andes, and is subjected to the influence of altitude and the local climates typical of mountainous regions, there should be an enormous diversity within all families, to which Spruce's enthusiastic remarks on the forests of Canelos, at the base of the Andean foothills of Ecuador, will testify. In the course of our two weeks work in the valley of the Río Pastaza between Puyo and Baños, Dr. Camp and I were able to collect 93 numbers of Rubiaceae, representing 75 species, of which 20 are new to science.

Standley's "Rubiaceae of Ecuador" contains 178 species and 45 genera. According to Standley (in litt.) 56 new and undescribed species are represented in my Ecuadorian collections alone. This nearly equals one third of the known rubiaceous flora of Ecuador. With the addition of some 30 species from my collections which are already described but not previously known from Ecuador, the known rubiaceous flora is increased by half. It is probable that the addition of novelties from the collections of Camp, Wiggins, Drew, Prescott, and Ownbey will double or more than double the known Rubiaceae of Ecuador, and Dr. Standley has already expressed the intention of revising his "Rubiaceae of Ecuador" when all the collections from

our work have reached him. To avoid the publication of *nomina nuda*, Dr. Standley's proposed new species will not be mentioned here although included in the statistics. He has given names to new species in the following genera (the number in parentheses is the number of new species in that genus): *Cephaëlis* (3), *Faramea* (4) *Hoffmannia* (3), *Holtonia* (1), *Manettia* (3), *Palicourea* (24), *Pentagonia* (1), *Psychotria* (14), *Rondeletia* (1), *Rustia* (1), and *Schradera* (1). Of these genera, *Holtonia*, *Rustia*, and *Schradera* are previously unreported from the Ecuadorian flora. I have already described a new species in the previously unreported genus *Joosia* (Steere 1943), and in the following list *Posoqueria*, *Chomelia*, and *Hemidiodia* were not heretofore known from Ecuador. The genus *Coccocypselium*, although not included in the "Rubiaceae of Ecuador," was later reported by Diels (1937).

In the following list of collections, geographic data are given in detail, in order that the origin of each specimen may be localized with some precision. Our work in Ecuador was hampered by the lack of accurate, large-scale maps of the regions which we explored, as well as by the lack of any sort of gazetteer, good or bad. The *Guía geográfica* and the excellent semi-topographic maps of each department, available in Colombia, were of great help there, both in planning explorations and in arriving at a common understanding on regions with land-owners and bark dealers, and I missed these aids when I moved from Colombia to Ecuador in July, 1943. The map of Ecuador published by Wolf in 1891, and distributed with his *Ecuador* (1892), is still the best in existence, even after more than fifty years. A useful, although reduced copy of it is easily available in Diels' work (1937). Later maps have all been copied from Wolf's, but in addition to including his errors, they have introduced new ones. The wall-map for schools prepared by Dr. Tufiño and published under government sponsorship in 1925 is useful because of its large scale.

According to some official maps, the Río Pastaza serves to divide the Oriente of Ecuador into two provinces, Napo-Pastaza on the north and Santiago-Zamora on the south; according to others, the Río Huamboya is the division line. The two provinces are accepted fairly generally in Ecuador except at the division point itself, where no distinction whatever is made between Napo-Pastaza and Santiago-Zamora, and the whole region is simply called "Oriente." Consequently, to avoid a violation of present-day usage in Ecuador, "Prov. Napo-Pastaza" has been applied to the Oriente east of the northernmost provinces, and "Prov. Oriente" to that part east of the central provinces of Tungarahua and Chimborazo. The observance of this usage also serves the useful purpose of keeping separate in the list the collections from the northernmost part of the Oriente region, at the Colombian frontier, and those from the valley of the Río Pastaza of the central Oriente.

In the following list, the specimens are cited by provinces from North to South. This arrangement also happens to coincide rather closely with the chronological order in which the collections were made. All the specimens seen by Dr. Standley are contained in the Herbarium of the Chicago Natural History Museum. A full set belongs to the United States National Herbarium, and a third set will be placed in the Herbarium of the University of Michigan, Ann Arbor. A complete set of the specimens which I collected jointly with Dr. W. H. Camp, and a fourth set of my own collections will be deposited in the Herbarium of the New York Botanical Garden.

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ECUADORIAN RUBIACEAE COLLECTED BY WILLIAM C. STEERE

ARCYTOPHYLLUM ARISTATUM Standl. PROV. CARCHI: Páramo above Tufiño, southeast slope of Volcán de Chiles, Cordillera Occidental, 12,000 ft. alt., Aug. 21, 1943, *Steere 8033, 8034;* Páramo de la Piedra, summit of Cordillera Oriental directly east of San Gabriel, 12,000 ft. alt., Oct. 21, 1943, *Steere 8122.* This species has already been reported from Carchi, as well as from the provinces of Azuay and Loja.

ARCYTOPHYLLUM CAPITATUM (Benth.) Schum. PROV. CARCHI: Páramo de la Piedra, very summit of Cordillera Oriental directly east of San Gabriel, 12,000 ft. alt., Oct. 21, 1943, *Steere 8121.* A shrub to 0.5 m. high with pink and lavender flowers; previously known from Ecuador without locality.

ARCYTOPHYLLUM THYMIFOLIUM (R. & P.) Standl. PROV. CARCHI: Roadside at Rumichaca (Ecuadorian-Colombian frontier), Interandean Valley just

north of Tulcán, 10,000 ft. alt., Oct. 3, 1943, *Steere 8090.* PROV. IMBABURA: Páramo de Pugarán, above Cahuasquí, west of Ibarra, Cordillera Occidental, 10,000 ft. alt., Dec. 13, 1943, *Steere 8194.* PROV. PICHINCHA: Dominant vegetation on arid slopes of steppe at kilometer 56 on Pan-American Highway south of Cayambe, Interandean Valley, 8000 ft. alt., Nov. 4, 1943, *Steere 8167.* PROV. TUNGARAHUA: Roadside just west of Píllaro, road to Ambato, Interandean Valley, 9000 ft. alt., Aug. 6, 1944, *Steere 8345.* The commonest species of *Arcytophyllum* in Ecuador, but not previously known from Carchi and Imbabura.

BORRERIA LAEVIS (Lam.) Griseb. PROV. CARCHI: Dry roadside, 5 kilometers east of Maldonado, Cordillera Occidental, 6000 ft. alt., Aug. 23, 1943, *Steere 8058.* PROV. IMBABURA: Along trail, Colonia Buenos Aires, west of Ibarra, Cordillera Occidental, 7500 ft. alt., Dec. 15, 1943, *Steere 8200.* PROV. LEÓN: Shaded bank, north side of Río Macuchi, near Esperanza, Cordillera Occidental, 5200 ft. alt., Sept. 8, 1943, *Steere 8077.* PROV. ORIENTE: Along trail near junction of Río Pastaza and Río Estancias, Cordillera Oriental, 4400 ft. alt., May 7, 1944, *Steere & Camp 8251.* A common tropical American weed not reported before from the highland provinces of Ecuador.

BORRERIA OCIMOIDES (Burm.) DC. PROV. CARCHI: Dry trailside, 5 kilometers east of Maldonado, Cordillera Occidental, 6000 ft. alt., Aug. 23, 1943, *Steere 8065.* PROV. ORIENTE: Along trail near Junction of Río Pastaza and Río Estancias, Cordillera Oriental, 4400 ft. alt., May 7, 1944, *Steere & Camp 8245, 8252.* A widely distributed tropical American weed previously known in Ecuador only from the province of Imbabura.

CEPHAËLIS AXILLARIS Sw. PROV. NAPO-PASTAZA: In deep wet forest above La Fama, Río Chingual, east of El Pun, Cordillera Oriental, 7200 ft. alt., Aug. 10, 1943, *Steere 8025.* This species has not been reported previously from Ecuador, although it is known from Colombia, Central America, and the West Indies.

CEPHAËLIS JAMESONII Standl. PROV. CARCHI: In deep forest below Tambo Jucal, west slope of Volcán de Chiles, Cordillera Occidental, 10,000 ft. alt.. Aug. 22, 1943, *Steere 8039;* In deep forest on high ridge across Río Plata from Tambo la Palma, west slope of Volcán de Chiles, Cordillera Occidental, 9000 ft. alt., Oct. 6, 1943, *Steere 8093a.* PROV. IMBABURA: In dense forest above Colonia Buenos Aires on trail to La Cocha, Cordillera Occidental, 8500 ft. alt., Dec. 15, 1943, *Steere 8203.* This species has proved to be of considerable interest because it seems to be associated in general with *Cinchona pitayensis* Wedd., and is the best indicator species which I was able to find in the Cordillera Occidental of Ecuador. Since the type material of this *Cephaëlis* came from the western slope of Volcán de Pichincha, it was considered worthwhile to search there for *Cinchona pitayensis,* on the basis of the association noted in the northern provinces of Carchi and Imbabura. As already reported (Steere 1944), the *Cinchona* was found as predicted.

CEPHAËLIS TOMENTOSA (Aubl.) Vahl. PROV. ORIENTE: In roadside forest 10 kilometers east of Mera, foothills of Cordillera Oriental, 4000 ft. alt., May 11, 1944, *Steere & Camp 8276.* A common and widespread tropical American species which has been reported from Ecuador only from the province of El Oro, in the western range.

CHOMELIA BARBELLATA Standl. PROV. ORIENTE: In dense forest east of Puyo, on trail to Arajuno, Cordillera Oriental (foothills), 3000 ft. alt., May

12, 1944, *Steere & Camp 8290.* A Peruvian species not previously known from Ecuador.

CINCHONA OFFICINALIS L. PROV. NAPO-PASTAZA: In dense, wet forest above Río Las Ollas, at junction with Río Chingual, Cordillera Oriental, 6250 ft. alt., Aug. 3, 1943, *Steere 8013;* On nearly vertical cuesta above Río Cofanes, at point called San Antonio, Cordillera Oriental, 7250 ft. alt., Oct. 23, 1943, *Steere 8134.* PROV. ORIENTE: In dense, wet forest, valley of Río Pastaza in zone of El Topo, Cordillera Oriental, 5500 ft. alt., May 2, 1944, *Steere & Camp 8226;* 4500 ft. alt., May 5, 1944, *Steere & Camp 8238;* 7000 ft. alt., May 10, 1944, *Steere & Camp 8271;* In deep, wet forest on flood-plain of Río Pastaza just south of Shell-Mera, May 13, 1944, 3500 ft. alt., *Steere & Camp 8300.* In Ecuador, this may be considered either a single extremely variable and complex species, or a group of reasonably distinct species or subspecies. For example, numbers 8226 and 8238 cited above represent a form with large, delicate leaves, whose bark is rich in alkaloids, giving an average of 1.5 per cent of quinine and an average of 4.5 per cent of total crystallizable alkaloids. Numbers 8013, 8134, and 8271 represent another form of higher altitudes, with much smaller leathery leaves, whose bark contains almost no quinine and a very low percentage (0.5–1.5) of total crystallizable alkaloids. In a critical revision of the genus, these will probably be considered as distinct species. This species (in the broad sense in which it is treated by Standley) has been known previously in Ecuador only from the province of Loja, in the southernmost part of the republic.

CINCHONA PITAYENSIS Wedd. PROV. CARCHI: On steep slopes, headwaters of Río la Plata, west slopes of Volcán de Chiles, Cordillera Occidental, 9770 ft. alt., Aug. 22, 1943, *Steere 8043;* 9700 ft. alt., Oct. 10, 1943, *Steere 8097;* Tambo Bretaña, above Río Bella Vista, 9000 ft. alt., Cordillera Oriental, Oct. 22, 1943, *Steere 8125;* Hacienda Indúgel, Interandean Valley directly east of San Gabriel, 9500 ft. alt., Oct. 27, 1943, *Steere 8153.* PROV. IMBABURA: Fila de Moinala, above Río Asabí, southwest slopes of Volcán de Cotacachi, Cordillera Occidental, 8500 ft. alt., Dec. 3, 1943, *Steere 8191;* Dense forest at headwaters of Río Rumichaca, old road between Colonia Buenos Aires and La Cocha, Cordillera Occidental west of Ibarra, 9500 ft. alt., Dec. 15, 1943, *Steere 8201.* The unsuspected existence of this species in Ecuador, its discovery, and its at present known distribution have been discussed at some length (Steere 1944). A curious feature of this species, now known well south of Quito, is that south of Pichincha, its alkaloid content drops markedly, and the bark contains very little quinine.

CINCHONA PUBESCENS Vahl. PROV. NAPO-PASTAZA: In clearing at Cesario, Río Chingual, Cordillera Oriental, 4750 ft. alt., Aug. 4, 1943, *Steere 8014;* At edge of clearing, Sebundoy, Río Chingual, 6250 ft. alt., Aug. 9, 1943, *Steere 8023.* PROV. CARCHI: At Tambo Bella Vista on summit between Río la Plata and Río San Juan, west slope of Volcán de Chiles, Cordillera Occidental, 8400 ft. alt., Aug. 23, 1943, *Steere 8053.* PROV. IMBABURA: In plaza of Colonia Buenos Aires, Cordillera Occidental west of Ibarra, 7450 ft. alt., Dec. 14, 1943, *Steere 8195.* PROV. PICHINCHA: Roadside at about kilometer 45, Quito-Santo Domingo Road, Cordillera Occidental, Nov. 9, 1943, *Steere 8168.* PROV. LEÓN: Hacienda Nanaló, Macuchi Mines region, Cordillera Occidental, 5500 ft. alt., Sept. 8, 1943, *Steere 8080.* PROV. ORIENTE: On bank of Río Estancias near junction with Río Pastaza, El Topo region, Cordillera Oriental, 4000 ft. alt., May 2, 1944, *Steere & Camp 8225;* Roadside not far

west of Puyo, road to Shell-Mera, 3000 ft. alt., May 12, 1944, *Steere & Camp 8299*. This species seems to occur on the slopes of the Andes throughout Ecuador, although it does not seem to have been reported previously from the northern half of the republic. Except for a high-yielding race cultivated in the province of Bolívar, this species produces almost no quinine and rather low percentages of other alkaloids, mostly cinchonine.

COCCOCYPSELUM CONDALIA Pers. PROV. ORIENTE: On bank of Río Estancias near junction with Río Pastaza, region of El Topo, Cordillera Oriental, 4400 ft. alt., May 7, 1944, *Steere & Camp 8248;* Roadside bank not far west of Puyo, road to Shell-Mera, 3000 ft. alt., May 12, 1944, *Steere & Camp 8297*. This species has been reported from the same general region by Diels (1937) as *C. umbellatum* Poir.

COFFEA ARABICA L. As noted by Standley (1931), this important plant is widely cultivated in Ecuador; I have seen it in nearly every province.

CONDAMINEA CORYMBOSA (R. & P.) DC. PROV. NAPO-PASTAZA: Trail along Río Chingual, northwest of Cesario, Cordillera Oriental, 5000 ft. alt., Aug. 4, 1943, *Steere 8016*. PROV. CARCHI: Forest just east of Maldonado, Río San Juan, Cordillera Occidental, 5450 ft. alt., Aug. 23, 1943, *Steere 8060*. PROV. ORIENTE: On bank of Río Estancias near junction with Río Pastaza, region of El Topo, Cordillera Oriental, 4400 ft. alt., May 7, 1944, *Steere & Camp 8255*. Previously reported in Ecuador from Loja (Standley 1931) and from the Pastaza valley (Diels 1937).

CORYNULA PILOSA (Benth.) Hook. PROV. CARCHI: Roadside, Hacienda Indúgel, east of San Gabriel, Interandean Valley, 9000 ft. alt., Oct. 21, 1943, *Steere 8118*. PROV. IMBABURA: In meadow below Páramo de Taminanga, above Río Asabí, west slope of Volcán de Cotacachi, Cordillera Occidental, 9000 ft. alt., Dec. 2, 1943, *Steere 8188*. PROV. PICHINCHA: Páramo above Chillogallo, south slope of Volcán de Pichincha, 11,300 ft. alt., May 20, 1944, *Steere & Camp 8324*. This species has been known in Ecuador only from the type locality in the province of Pichincha.

ELAEAGIA UTILIS (Goudot) Wedd. PROV. CARCHI: In dense forest about 10 kilometers east of Maldonado, Río San Juan, Cordillera Occidental, 6500 ft. alt., *Steere 8069*. PROV. IMBABURA: In dense forest along Río Lita, below Colonia Buenos Aires, Cordillera Occidental west of Ibarra, 6500 ft. alt., Dec. 20, 1943, *Steere 8211*. PROV. ORIENTE: In dense, wet forest, valley of Río Pastaza in region of El Topo, Cordillera Oriental, 4750 ft. alt., May 5, 1944, *Steere & Camp 8240*. Although all these specimens are sterile, the plants from which they came resembled very closely true *Elaeagia utilis* which I have seen in Colombia. Furthermore, all these specimens bear the characteristic resinous gum in the upper nodes.

FARAMEA COERULESCENS Schum. & Krause. PROV. CARCHI: In forest below Tambo la Palma, headwaters of Río la Plata, west slope of Volcán de Chiles, Cordillera Occidental, 9500 ft. alt., Oct. 5, 1943, *Steere 8092*. Previously reported from the provinces of Azuay and Loja, in the southernmost part of Ecuador.

FARAMEA MAYNENSIS Spruce. PROV. ORIENTE: In dense forest, steep valley of Río Pastaza between El Topo and Baños, Cordillera Oriental, 5500 ft. alt., May 10, 1944, *Steere & Camp 8267*. Reported from Ecuador only from the province of Guayas.

FARAMEA OBLONGIFOLIA Standl. PROV. IMBABURA: In forest, Río Pamplona, Selva Alegre, west slope of Volcán de Cotacachi, Cordillera Occidental, 7000

ft. alt., Nov. 26, 1943, *Steere 8185*. A Colombian species not previously reported from Ecuador.

GALIUM APARINE L. PROV. CARCHI: Roadside, Hacienda Indúgel, Interandean Valley directly east of San Gabriel, 9000 ft. alt., Oct. 27, 1943, *Steere 8161;* Along trail just east of Huaca, 10,000 ft. alt., Oct. 31, 1943, *Steere 8164;* In clearing above Río La Mina, Colonia Huaqueña, 10,000 ft. alt., Nov. 1, 1943, *Steere 8166*. A cosmopolitan weed not reported from Ecuador until very recently (Acosta-Solís 1943) from the province of Pichincha.

GALIUM CANESCENS HBK. PROV. NAPO-PASTAZA: Side of trail along Río Chingual, between El Pun and Los Andes, Cordillera Oriental, 9500 ft. alt., July 31, 1943, *Steere 8005a, 8006*. PROV. CARCHI: On steep bank of Río Chiles, Tufiño, Interandean Valley west of Tulcán, 10,700 ft. alt., Aug. 20, 1943, *Steere 8028;* Along trail below Tambo Jucal, west slope of Volcán de Chiles, Cordillera Occidental, 10,000 ft. alt., Aug. 22, 1943, *Steere 8042;* Trailing over roadside bank, Rumichaca (Ecuadorjan-Colombian frontier), Interandean Valley north of Tulcán, 10,000 ft. alt., Oct. 3, 1943, *Steere 8091;* Roadside, Hacienda Indúgel, east of San Gabriel, Interandean Valley, 9000 ft. alt., Oct. 21, 1943, *Steere 8119*. PROV. PICHINCHA: Páramo above Chillogallo, south slope of Volcán de Pichincha, Cordillera Occidental, 11,300 ft. alt., May 20, 1944, *Steere & Camp 8321*. PROV. LEÓN: On steep bank in forest above Pilaló, headwaters of Río Macuchi, Cordillera Occidental, 8500 ft. alt., Sept. 10, 1943, *Steere 8084*. Standley (1931) has cited five Ecuadorian specimens, all from the province of Pichincha.

GALIUM PILIFERUM HBK. PROV. CARCHI: On steep bank of Río Chiles, in village of Tufiño, Interandean Valley west of Tulcán, 10,700 ft. alt., Aug. 20, 1943, *Steere 8028* (in part); Roadside at point called Salado, above El Pun, east of Tulcán, Cordillera Oriental, 9500 ft. alt., Oct. 15, 1943, *Steere 8105*. PROV. PICHINCHA: Páramo above Chillogallo, south slope of Volcán de Pichincha, Cordillera Occidental, 11,300 ft. alt., May 20, 1944, *Steere & Camp 8323*.

GALIUM TETRAPLASIUM Standl. PROV. CARCHI: On steep banks of Río Chiles, in village of Tufiño, Interandean Valley west of Tulcán, 10,700 ft. alt., Aug. 20, 1943, *Steere 8029*. Not previously reported from Ecuador.

GOMOZIA GRANADENSIS L. (*Nertera depressa* Banks & Soland.) PROV. NAPO-PASTAZA: In trail along Río Chingual near Hacienda Macarenas, east of El Pun, Cordillera Oriental, alt. 9000 ft., July 29, 1943, *Steere 8002;* Bank of Río Alegría near junction with Río Chingual, 6140 ft. alt., Aug. 3, 1943, *Steere 8012*. PROV. CARCHI: On roadside bank in páramo between Tulcán and El Pun, Cordillera Oriental, 11,000 ft. alt., July 29, 1943, *Steere 8000;* October 15, 1943, *Steere 8102;* On rock near Tambo la Palma, headwaters of Río la Plata, west slope of Volcán de Chiles, Cordillera Occidental, 9000 ft. alt., Aug. 22, 1943, *Steere 8041;* Oct. 7, 1943, *Steere 8095*. PROV. PICHINCHA: Páramo above Chillogallo, south slope of Volcán de Pichincha, Cordillera Occidental, 11,300 ft. alt., May 20, 1944, *Steere & Camp 8318*. A very common plant which has not before been reported from the northernmost provinces. Numbers 8041 and 8095 are a form with juniper-like leaves and a very different manner of growth. I suspect that a critical revision of all material would result in the segregation of these specimens as a new species.

GONZALAGUNIA CORNIFOLIA (HBK.) Standl. PROV. ORIENTE: On bank, east of Puyo, trail to Canelos and Arajuno, foothills of Cordillera Oriental, 3000 ft. alt., May 12, 1944, *Steere & Camp 8296*. Already reported from the same general region by Diels (1937).

GONZALAGUNIA DEPENDENS R. & P. PROV. CARCHI: Roadside, Tambo Encanto, above Río la Plata, west slope of Volcán de Chiles, Cordillera Occidental, 8500 ft. alt., Aug. 26, 1943, *Steere 8073;* 5 kilometers east of Maldonado, Aug. 26, 1943, *Steere 8072.* PROV. ORIENTE: Bank of Río Estancias near junction with Río Pastaza, region of El Topo, Cordillera Oriental, 4400 ft. alt., May 7, 1944, *Steere & Camp 8253;* In forest, flood plain of Río Pastaza just south of Shell-Mera, 3500 ft. alt., May 13, 1944, *Steere & Camp 8300.* Previously reported only from the provinces of Loja and Pichincha, in Ecuador.

GONZALAGUNIA RUDIS Standl. PROV. ORIENTE: In dense forest in valley of Río Pastaza, region of El Topo, Cordillera Oriental, 4500 ft. alt., May 5, 1944, *Steere & Camp 8243.* A Panamanian and Colombian species not before reported from Ecuador.

GONZALAGUNIA SORORIA Standl. PROV. CARCHI: Below Tambo Bella Vista, west slope of Volcán de Chiles, Cordillera Occidental, 7000 ft. alt., Aug. 23, 1943, *Steere 8056.* PROV. IMBABURA: Trail above Selva Alegre, southwest slope of Volcán de Cotacachi, Cordillera Occidental, 10,000 ft. alt., Nov. 24, 1943, *Steere 8181.* PROV. ORIENTE: Bank of Río Estancias at junction with Río Pastaza, region of El Topo, Cordillera Oriental, 4400 ft. alt., May 7, 1944, *Steere & Camp 8254.* Previously known only from the type locality in the province of El Oro, Ecuador.

GUETTARDA HIRSUTA (R. & P.) Pers. PROV. CARCHI: Headwaters of Río la Plata, west slope of Volcán de Chiles, Cordillera Occidental, 9500 ft. alt., Aug. 22, 1943, *Steere 8045.* PROV. IMBABURA: Fila de Moinala, above Río Asabí, west slope of Volcán de Cotacachi, Cordillera Occidental, 9400 ft. alt., Dec. 3, 1943, *Steere 8190;* in dense ridge forest, trail between Colonia Buenos Aires and Guajara, Río Mira, Cordillera Occidental, 10,000 ft. alt., Dec. 18, 1943, *Steere 8207.* Previously known in Ecuador from a single specimen without locality.

GUETTARDA SABICEOIDES Standl. PROV. CARCHI: Chachasal, 8 kilometers south of El Pun, Cordillera Oriental, 9000 ft. alt., Oct. 19, 1943, *Steere 8115;* Nov. 10, 1943, *Steere 8180.* PROV. ORIENTE: Between Río Pastaza and road, El Topo, Cordillera Oriental, 4000 ft. alt., May 8, 1944, *Steere & Camp 8257;* In forest, Shell-Mera, 3500 ft. alt., May 11, 1944, *Steere & Camp 8280;* Along trail, not far west of Puyo, 3000 ft. alt., May 12, 1944, *Steere & Camp 8287.* A Colombian species not previously reported from Ecuador.

HAMELIA PATENS Jacq. PROV. LEÓN: On bank of Río Macuchi just below electric plant for Macuchi Mines, 3500 ft. alt., Sept. 11, 1943, *Steere 8089.* A common and widespread tropical American species reported from several Ecuadorian provinces, but not previously from León.

HAMELIA PEDICELLATA Wernham. PROV. ORIENTE: On east bank of Río Puyo, across from village of Puyo, foothills of Cordillera Oriental, 3000 ft. alt., May 12, 1944, *Steere & Camp 8292.* Previously reported in Ecuador only from the province of Guayas.

HEMIDIODIA OCIMIFOLIA (Willd.) Schum. PROV. IMBABURA: Along trail, Río Mira near junction with Río Lita, Cordillera Occidental, 2000 ft. alt., Nov. 22, 1943, *Steere 8215.* A common weed in tropical America which by some accident does not seem to have been reported from Ecuador.

HILLIA PARASITICA Jacq. PROV. CARCHI: Creeping over bank along trail, just below Tambo Bella Vista, Río San Juan, Cordillera Occidental, 8300 ft. alt., Aug. 26, 1943, *Steere 8070.* PROV. IMBABURA: On steep hillside, Río

Lita below Colonia Buenos Aires, Cordillera Occidental west of Ibarra, 7000 ft. alt., Dec. 14, 1943, *Steere 8196*. Previously known in Ecuador only from a Spruce specimen without locality data.

HOFFMANNIA ECUATORIANA Standl. PROV. ORIENTE: In deep, wet forest, valley of Río Pastaza, region of El Topo, Cordillera Oriental, 4400 ft. alt., May 4, 1944, *Steere & Camp 8230*. This specimen was collected in the same general zone as the type specimen and is a very conspicuous species because of the bright, China-red flowers. It has been collected and reported from this region also by Diels.

HOFFMANNIA SPRUCEI Standl. PROV. NAPO-PASTAZA: Along stream, near La Fama, Río Chingual, Cordillera Oriental, 7000 ft. alt., Aug. 2, 1943, *Steere 8011*. PROV. CARCHI: At bridge over Río Bella Vista half day from junction with Río Cofanes, Cordillera Oriental east of San Gabriel, 8050 ft. alt., Oct. 22, 1943, *Steere 8128*. PROV. LEÓN: In deep, wet forest, Hacienda Nanaló, Macuchi Mines region, Cordillera Occidental, 5500 ft. alt., Sept. 8, 1943, *Steere 8083*. Previously reported from one specimen without locality data.

ISERTIA ALBA Sprague. PROV. ORIENTE: On bank of Río Estancias near junction with Río Pastaza, region of El Topo, Cordillera Oriental, 4400 ft. alt., May 7, 1944, *Steere & Camp 8247*. This is a common and abundant tree in the valley of the Río Pastaza, but has not been reported from Ecuador. However, in view of its occurrence in Colombia and Peru, its discovery in Ecuador is not surprising.

ISERTIA PITTIERI (Standl.) Standl. PROV. IMBABURA: Forest along Río Mira, near junction with Río Lita, Cordillera Occidental, 2000 ft. alt., Nov. 22, 1943, *Steere 8221*. A Colombian species not previously known from Ecuador.

JOOSIA PULCHERRIMA Steere. PROV. NAPO-PASTAZA: In wet, mossy forest above Río Garrapatera, east of La Bonita, Río Chingual, Cordillera Oriental, 7000 ft. alt., Aug. 6, 1943, *Steere 8018;* In wet forest above La Fama, Río Chingual, 7200 ft. alt., Aug. 10, 1943, *Steere 8026*. PROV. CARCHI: Common in dense forest along Río Bella Vista several hours above its junction with Río Cofanes, Cordillera Oriental, 8000 ft. alt., Oct. 22, 1943, *Steere 8129*. The last specimen cited here was not mentioned in the original description of the species (Steere 1943) because the manuscript was already in the hands of the printer at the time 8129 was collected.

LADENBERGIA MACROCARPA (Vahl) Klotzsch. PROV. NAPO-PASTAZA: In deep forest, valley of Río Chingual east of El Pun, Cordillera Oriental, 9000 ft. alt., July 29, 1943, *Steere 8004*. PROV. CARCHI: At Tambo Encanto, Río la Plata, west slope of Volcán de Chiles, Cordillera Occidental, 8700 ft. alt., Aug. 22, 1943, *Steere 8048;* Below El Pun, toward Río Chingual, Cordillera Oriental, 9000 ft. alt., Oct. 16, 1943, *Steere 8108*. Reported only from the southernmost provinces of Loja and Azuay.

LADENBERGIA MAGNIFOLIA (R. & P.) Klotzsch. PROV. NAPO-PASTAZA: In clearing at Cesario, Río Chingual, Cordillera Oriental, 4750 ft. alt., Aug. 4, 1943, *Steere 8015*. PROV. CARCHI: In forest, about 10 kilometers east of Maldonado, Río San Juan, Cordillera Occidental, 6780 ft. alt., August 23, 1943, *Steere 8059*. I have attached this name to specimens which occur at and below the zone of *Cinchona pubescens* and which, as in Colombia, have hollow twigs.

MACROCNEMUM SPRUCEI Rusby. PROV. NAPO-PASTAZA: Deep forest above La Fama, Río Chingual, Cordillera Oriental, 7000 ft. alt., Aug. 2, 1943, *Steere 8008*. A Bolivian species not before reported from Ecuador.

MANETTIA ECHITIDEA Standl. PROV. CARCHI: In tree along trail just east of Huaca, Interandean Valley, 10,000 ft. alt., Oct. 31, 1943, *Steere 8162*. Previously reported from Ecuador only from the province of Pichincha.

MANETTIA EVENIA Sprague. PROV. CARCHI: In forest on high ridge between Río Bella Vista and Río Tigre Chico, both tributaries of Río Cofanes, Cordillera Oriental, 9000 ft. alt., Oct. 24, 1943, *Steere 8143;* Hacienda Indúgel, Interandean Valley directly east of San Gabriel, 9000 ft. alt., Oct. 27, 1943, *Steere 8155*. Previously reported from Ecuador from the province of Pichincha.

MANETTIA FLEXILIS Brandeg. PROV. CARCHI: Bank of Río la Plata near junction with Río San Juan, just east of Maldonado, Cordillera Occidental, 5200 ft. alt., *Steere 8068*. Otherwise known in Ecuador only from the province of Chimborazo.

MANETTIA PICHINCHENSIS Wernham. PROV. PICHINCHA: Páramo above Chillogallo, south slope of Volcán de Pichincha, Cordillera Occidental, 11,300 ft. alt., May 20, 1944, *Steere & Camp 8322*. This species is known only from Pichincha, but many collections have been made there.

MANETTIA RACEMOSA R. & P. PROV. ORIENTE: Among shrubs, bank of Río Estancias at its junction with Río Pastaza, region of El Topo, Cordillera Oriental, 4400 ft. alt., May 7, 1944, *Steere & Camp 8250*. A Peruvian species, not before reported from Ecuador.

MANETTIA RECURVA Sprague. PROV. CARCHI: In forested ravine at very edge of páramo, Tambo Jucal, west slope of Volcán de Chiles, Cordillera Occidental, 11,100 ft. alt., Aug. 21, 1943, *Steere 8037;* At edge of forest, Tambo Encanto, 8700 ft. alt., Aug. 22, 1943, *Steere 8050;* Hacienda Indúgel, Interandean Valley directly east of San Gabriel, 9000 ft. alt., Oct. 27, 1943, *Steere 8154*. These are apparently the first collections from the northern half of Ecuador.

MANETTIA SKUTCHII Standl. PROV. ORIENTE: On shrub several kilometers west of Puyo, road to Shell-Mera, foothills of Cordillera Oriental, 3000 ft. alt., May 12, 1944, *Steere & Camp 8284;* On tree, several kilometers east of Puyo, trail to Arajuno and Canelos, May 12, 1944, *Steere & Camp 8291;* Roadside just west of Shell-Mera, May 13, 1944, *Steere & Camp 8317*. According to Standley (in litt.), "This species has been known heretofore only from the original collection," which was made in 1939 in the same general region.

MANETTIA TRIANAE Wernham. PROV. CARCHI: Chorrera de la Loma Rinconada, south of El Pun, Cordillera Occidental, 9000 ft. alt., Oct. 19, 1943, *Steere 8117*. This is the first report from the northern half of Ecuador; otherwise known from the province of Tungurahua.

PALICOUREA ANGUSTIFOLIA HBK. PROV. CARCHI: Chachasal, 8 kilometers south of El Pun, Cordillera Oriental, 9000 ft. alt., Oct. 19, 1943, *Steere 8116;* In dense forest above Río Bella Vista, a tributary of Río Cofanes, Cordillera Oriental, 8000 ft. alt., Oct. 22, 1943, *Steere 8131;* 7500 ft. alt., Oct. 24, 1943, *Steere 8140*. PROV. IMBABURA: Dense forest above Río Asabi, north side, west slope of Volcán de Cotacachi, Cordillera Occidental, 8500 ft. alt., Dec. 2, 1943, *Steere 8189*. PROV. ORIENTE: Dense forest, headwaters of Río Tigre, which joins Río Pastaza at El Topo, Cordillera Oriental, 5000 ft. alt., May

8, 1944, *Steere & Camp 8261*. A beautiful species definitely known previously in Ecuador only from the province of Tungurahua.

PALICOUREA BALNEARIA Standl. PROV. NAPO-PASTAZA: In deep forest, valley of Río Chingual near Hacienda Macarenas, east of El Pun, Cordillera Oriental, 9000 ft. alt., July 29, 1943, *Steere 8003*. This species has been known apparently only from the type locality, in the province of Tungurahua.

PALICOUREA CALANTHA Standl. PROV. LEÓN: In dense forest, Hacienda Nanaló, region of Macuchi Mines, Cordillera Occidental, 5500 ft. alt., Sept. 8, 1943, *Steere 8079*. The previously known distribution of this species in Ecuador has been in the province of Pichincha, the type locality.

PALICOUREA CALDASANA Standl. PROV. CARCHI: Loma Bretaña, Mirador, southeast of El Pun, Cordillera Oriental, 10,000 ft. alt., Oct. 18, 1943, *Steere 8113;* In forest along Río Bella Vista, headwaters of Río Cofanes, Cordillera Oriental, 8000 ft. alt., Oct. 22, 1943, *Steere 8130*. A Colombian species, not previously reported from Ecuador.

PALICOUREA CALOTHYRSUS Schum. & Krause. PROV. LEÓN: In dense forest above Pilaló, headwaters of Río Macuchi, Cordillera Occidental, 8500 ft. alt., Sept. 10, 1943, *Steere 8088*. Although several collections of this species have been reported from Ecuador, it has not apparently been collected previously in this particular province.

PALICOUREA CHIMBORACENSIS Standl. PROV. CARCHI: On bank of Río San Juan, just west of Maldonado, Cordillera Occidental, 5000 ft. alt., Aug. 24, 1943, *Steere 8066*. This species has been known heretofore only from the type locality, "at the foot of Mt. Chimborazo."

PALICOUREA CROCEA (Sw.) R. & S. PROV. CARCHI: In forest on terrace of Río San Juan, just east of Madonado, Cordillera Occidental, 5460 ft. alt., Aug. 23, 1943, *Steere 8064*. PROV. IMBABURA: In forest, Plaza de Selva Alegre, southwest slope of Volcán de Cotacachi, Cordillera Occidental, 4500 ft. alt., Nov. 28, 1943, *Steere 8186*. A widely distributed tropical American species, not previously reported from Ecuador.

PALICOUREA EGENA Standl. PROV. CARCHI: In forest, Hacienda Indúgel, Interandean Valley directly east of San Gabriel, 9000 ft. alt., Oct. 27, 1943, *Steere 8157;* In forest along trail, just east of Huaca, 10,000 ft. alt., Oct. 31, 1943, *Steere 8163*. The only collection of this species reported from Ecuador is from "Province of Pasto" (Standley 1931). Since the old province of Pasto, or Nariño, has had very flexible boundaries, it is difficult to know if Jameson's specimen came from present-day Ecuador, or from Colombia.

PALICOUREA FLAVESCENS HBK. PROV. CARCHI: In forest above Río Bella Vista, headwaters of Río Cofanes, Cordillera Oriental, 8500 ft. alt., Oct. 26, 1943, *Steere 8148*. Previously reported from the province of Carchi on the basis of a Lehmann specimen from "Mt. Tulcán."

PALICOUREA GUIANENSIS Aubl. PROV. ORIENTE: On terrace above Río Estancias near junction with Río Pastaza, region of El Topo, Cordillera Oriental, 4400 ft. alt., May 7, 1944, *Steere & Camp 8249*. Previously known in Ecuador from the provinces of El Oro and Chimborazo.

PALICOUREA HOLMGRENII Standl. PROV. CARCHI: In forest above Hacienda Indúgel, Interandean Valley directly east of San Gabriel, 9500 ft. alt., Oct. 21, 1943, *Steere 8120*. Previously known in Ecuador only from the type locality in the province of Pichincha.

PALICOUREA HOSPITALIS Standl. PROV. IMBABURA: Dense forest along trail above Selva Alegre, southwest slope of Volcán de Cotacachi, Cordillera Occi-

dental, 9000 ft. alt., Nov. 24, 1943, *Steere 8182.* PROV. ORIENTE: In dense, wet forest at headwaters of Río Tigre, which joins Río Pastaza at El Topo, Cordillera Oriental, 5300 ft. alt., May 9, 1944, *Steere & Camp 8263;* In dense, wet forest on high ridge between El Topo and Baños, 7500 ft. alt., May 10, 1944, *Steere & Camp 8272;* On bank of small stream just west of Shell-Mera, 3600 ft. alt., May 13, 1944, *Steere & Camp 8316.* This species has been known previously only from the type locality in southern Ecuador.

PALICOUREA HUIGRENSIS Standl. PROV. CARCHI: In forest, Tambo la Palma, headwaters of Río la Plata, west slope of Volcán de Chiles, Cordillera Occidental, 9500 ft. alt., Oct. 5, 1943, *Steere 8086, 8092a;* In forest above El Pun, east of Tulcán, Cordillera Oriental, 9000 ft. alt., Oct. 16, 1943, *Steere 8107.* Known previously only from the type locality in the province of Chimborazo and from Azuay.

PALICOUREA KALBREYERI Standl. PROV. CARCHI: Río Chingual at Sebundoy, Cordillera Oriental, 6200 ft. alt., Nov. 6, 1943, *Steere 8174.* A Colombian species, not reported from Ecuador before.

PALICOUREA LASIANTHA Krause. PROV. ORIENTE: In dense, wet forest, headwaters of Río Tigre, which joins Río Pastaza at El Topo, Cordillera Oriental, 5300 ft. alt., May 9, 1943, *Steere & Camp 8264.* This appears to be the first definitely known locality in Ecuador, as Standley (1931) reports only a Pearce specimen from "Andes."

PALICOUREA LEVIS Standl. PROV. CARCHI: In forest at Tambo Encanto, headwaters of Río La Plata, west slope of Volcán de Chiles, Cordillera Occidental, 8700 ft. alt., Aug. 22, 1943, *Steere 8049;* In forest above Hacienda Indúgel, Interandean Valley directly east of San Gabriel, 9000 ft. alt., Oct. 27, 1943, *Steere 8156, 8158.* Standley cites three specimens, but from no locality north of Quito.

PALICOUREA LUGUBRIS Schum. & Krause. PROV. IMBABURA: In forest along Río Mira near junction with Río Lita, Cordillera Occidental, 2000 ft. alt., Nov. 22, 1943, *Steere 8222.* PROV. ORIENTE: In forest along trail between Shell-Mera and Puyo, perhaps 5 kilometers east of Shell-Mera, foothills of Cordillera Oriental, 3000 ft. alt., May 12, 1944, *Steere & Camp 8286.* Not previously reported from either province cited here.

PALICOUREA OREADIUM Standl. PROV. CARCHI: In last bit of forest at edge of páramo, Tambo Jucal, west slope Volcán de Chiles, Cordillera Occidental, 11,100 ft. alt. Aug. 21, 1943, *Steere 8036;* Below Tambo Jucal, 10,000 ft. alt., Aug. 22, 1943, *Steere 8038;* In forest above El Pun, east of Tulcán, Cordillera Oriental, 10,000 ft. alt., Oct. 15, 1943, *Steere 8103, 8104;* Terrace of Río Chingual, below El Pun, 9000 ft. alt., Oct. 16, 1943, *Steere 8109;* In forest just at tree line, below Páramo de la Piedra, Cordillera Oriental, 11,000 ft. alt., Oct. 21, 1943, *Steere 8123;* 10,500 ft. alt., Oct. 22, 1943, *Steere 8124;* 9000 ft. alt., *Steere 8126;* In forest above Río Bella Vista, headwaters of Río Cofanes, 9000 ft. alt., Oct. 24, 1943, *Steere 8141;* In forest above Hacienda Indúgel, Interandean Valley directly east of San Gabriel, 10,500 ft. alt., Oct. 27, 1943, *Steere 8152.* This species has previously been known from the type locality, in southern Ecuador.

PALICOUREA PASTI Wernham. PROV. CARCHI: In forest above Hacienda Indúgel, Interandean Valley directly east of San Gabriel, 9000 ft. alt., Oct. 27, 1943, *Steere 8159.* The previous reports of this species in Ecuador give no locality data.

POSOQUERIA LATIFOLIA (Rudge) R. & S. PROV. NAPO-PASTAZA: In forest, Las Ollas, Río Chingual, Cordillera Oriental, 6500 ft. alt., Nov. 7, 1943, *Steere 8175*. A common enough species in Colombia and Peru, but not before reported from Ecuador.

PSYCHOTRIA BRACHIATA Sw. PROV. ORIENTE: In dense, wet forest, valley of Río Pastaza, region of El Topo, Cordillera Oriental, 4400 ft. alt., May 4, 1944, *Steere & Camp 8233;* 4750 ft. alt., May 5, 1944, *Steere & Camp 8242;* In forest at Shell-Mera, 3500 ft. alt., May 11, 1944, *Steere & Camp 8279*. Apparently known otherwise in Ecuador only from the southermost region currently in dispute between Ecuador and Peru.

PSYCHOTRIA BULLATIFOLIA Standl. PROV. ORIENTE: In dense, wet forest, flood plain of Río Pastaza, just south of Shell-Mera, foothills of Cordillera Oriental, 3500 ft. alt., May 13, 1944, *Steere & Camp 8307*. A Peruvian species, new for Ecuador.

PSYCHOTRIA CUSPIDATA Bredem. PROV. NAPO-PASTAZA: In deep forest, trail between Cesario and La Bonita, Río Chingual near junction with Río Sucio, Cordillera Oriental, 6000 ft. alt., Aug. 7, 1943, *Steere 8019*. Widely distributed in tropical America, but not previously reported from Ecuador.

PSYCHOTRIA HARTWEGIANA Standl. PROV. CARCHI: In forest, slopes of El Mirador, southeast of El Pun, Cordillera Oriental, 10,000 ft. alt., Oct. 17, 1943, *Steere 8112;* Above Tambo Bretaña, headwaters of Río Cofanes, Cordillera Oriental, 10,500 ft. alt., Oct. 27, 1943, *Steere 8151;* In forest above Huaca, to the east, Interandean Valley, 11,000 ft. alt., Oct. 31, 1943, *Steere 8165*. Although reported from Colombia and Bolivia, this species has not been known in Ecuador before.

PSYCHOTRIA HIRTA Humb. & Bonpl. PROV. CARCHI: In dense, wet, virgin forest across Río Plata from Tambo La Palma, west slope of Volcán de Chiles, Cordillera Occidental, 9000 ft. alt., Oct. 6, 1943, *Steere 8093;* In deep forest, nearly vertical cuesta above Río Cofanes, Cordillera Oriental, 7250 ft. alt., Oct. 23, 1943, *Steere 8135*. Standley does not report this species from Ecuador.

PSYCHOTRIA JAMESONIANA Standl. PROV. ORIENTE: In deep forest on steep ridge between El Topo and Baños, valley of Río Pastaza, Cordillera Oriental, 6000 ft. alt., May 10, 1944, *Steere & Camp 8268*. This species is not included in the "Rubiaceae of Ecuador."

PSYCHOTRIA LATERIFLORA Standl. PROV. CARCHI: In wet forest above Tambo Bretaña, headwaters of Río Cofanes, Cordillera Oriental, 10,000 ft. alt., Oct. 27, 1943, *Steere 8150*. A Colombian species, not previously reported from Ecuador.

PSYCHOTRIA MACROPHYLLA R. & P. PROV. NAPO-PASTAZA: In deep virgin forest, Sebundoy, Río Chingual, Cordillera Oriental, 6300 ft. alt., Aug. 9, 1943, *Steere 8022*. PROV. CARCHI: In forest along trail between Tambo Bella Vista and Maldonado, west slope Volcán de Chiles, Cordillera Occidental, 7500 ft. alt., Aug. 23, 1943, *Steere 8054;* 5450 ft. alt., *Steere 8061;* In deep, wet forest across Río la Plata from Tambo la Palma, 9000 ft. alt., Oct. 6, 1943, *Steere 8094;* In forest above Río Bella Vista, headwaters of Río Cofanes, Cordillera Oriental, 8000 ft. alt., Oct. 22, 1943, *Steere 8132*. PROV. IMBABURA: In forest, Fila de Moinala, above Río Asabí, west slope Volcán de Cotacachi, Cordillera Occidental, 9400 ft. alt., Dec. 3, 1943, *Steere 8192*. PROV. LEÓN: In deep, wet forest, Hacienda Nanaló, Macuchi Mines region, Cordillera Occidental, 5500 ft. alt., Sept. 8, 1943, *Steere 8081;* above Pilaló,

headwaters of Río Macuchi, 8500 ft. alt., Sept. 10, 1943, *Steere 8085.* PROV. ORIENTE: Dense, wet forest, valley of Río Pastaza, region of El Topo, Cordillera Oriental, 4400 ft. alt., May 4, 1944, *Steere & Camp 8232;* In forest, headwaters of Río Tigre, which joins Río Pastaza at El Topo, 5400 ft. alt., May 9, 1944, *Steere & Camp 8265;* In deep wet forest on flood plain of Río Pastaza just south of Shell-Mera, foothills of Cordillera Oriental, 3500 ft. alt., May 13, 1944, *Steere & Camp 8304, 8305, 8314.* A common, abundant, and apparently extremely variable species in Ecuador. It has been reported with certainty only from the provinces of Guayas and Pichincha (Standley 1931).

PSYCHOTRIA PATENS Sw. PROV. IMBABURA: In forest along Río Mira, near junction with Río Lita, Cordillera Occidental, 2000 ft. alt., Nov. 22, 1943, *Steere 8214.* Widely distributed in tropical America, but not reported previously from Ecuador.

PSYCHOTRIA PILOSA R. & P. PROV. ORIENTE: On bank of Río Estancias near junction with Río Pastaza, region of El Topo, Cordillera Oriental, 4400 ft. alt., May 7, 1944, *Steere & Camp 8256;* In forest at Shell-Mera, foothills of Cordillera Oriental, 3500 ft. alt., May 11, 1944, *Steere & Camp 8282;* In forest just east of Puyo, on trail to Arajuno and Canelos, 3000 ft. alt., May 12, 1944, *Steere & Camp 8293;* In dense, wet forest on flood-plain of Río Pastaza, just south of Shell-Mera, 3500 ft. alt., May 13, 1944, *Steere & Camp 8306.* A Peruvian and Bolivian species not previously reported from Ecuador.

PSYCHOTRIA RECORDIANA Standl. PROV. LEÓN: In deep forest, Hacienda Nanaló, Macuchi Mines region, Cordillera Occidental, 5500 ft. alt., Sept. 8, 1943, *Steere 8082.* This species is known otherwise only from the type locality in the parallel valley of the Río Saloya, Provincia de Pichincha, just to the north.

PSYCHOTRIA RIMBACHII Standl. PROV. IMBABURA: In forest along Río Mira, near junction with Río Lita, Cordillera Occidental, 2000 ft. alt., Nov. 22, 1943, *Steere 8213, 8218.* This species was not included by Standley in his "Rubiaceae of Ecuador" (1931).

PSYCHOTRIA RUFESCENS H. & B. PROV. IMBABURA: In forest along Río Mira, near junction with Río Lita, Cordillera Occidental, 2000 ft. alt., Nov. 22, 1943, *Steere 8217.* Previously reported in Ecuador only from the coast.

PSYCHOTRIA TENUIFOLIA Sw. PROV. ORIENTE: In wet forest east of Shell-Mera, trail to Puyo, foothills of Cordillera Oriental, 3000 ft. alt., May 12, 1944, *Steere & Camp 8285.* Concerning this collection, Standley says (in litt.) "A species common in Central America and the West Indies, but not recorded for South America. I can not find any character for separating the Ecuadorian plant."

RELBUNIUM CILIATUM (R. & P.) Hemsl. PROV. PICHINCHA: Páramo above Chillogallo, south slope of Volcán de Pichincha, Cordillera Occidental, 11,300 ft. alt., May 20, 1944, *Steere & Camp 8319.* A species widely distributed in Ecuador.

RELBUNIUM HIRSUTUM (R. & P.) Schum. PROV. CARCHI: On steep bank of Río Chiles, in village of Tufiño, Interandean Valley west of Tulcán, 10,700 ft. alt., Aug. 20, 1943, *Steere 8030;* Among sedges in pure páramo, west slope of Volcán de Chiles, Cordillera Occidental, 13,000 ft. alt., Aug. 27, 1943, *Steere 8075;* In páramo above El Pun, east of Tulcán, 11,500 ft. alt., Oct. 15, 1943, *Steere 8099;* Roadside, Hacienda Indúgel, Interandean Valley directly

east of San Gabriel, 9000 ft. alt., Oct. 27, 1943, *Steere 8160*. Previously reported from Carchi on the basis of a specimen collected by Hitchcock.

RELBUNIUM HYPOCARPIUM (L.) Hemsl. PROV. CARCHI: In fencerow above Tufiño, Interandean Valley west of Tulcán, 11,000 ft. alt., Aug. 21, 1943, *Steere 8032;* Along trail below Tambo Jucal, west slope Volcán de Chiles, Cordillera Occidental, 10,000 ft. alt., Aug. 22, 1943, *Steere 8040;* Tambo Bella Vista, 8400 ft. alt., Aug. 23, 1943, *Steere 8052;* In páramo above El Pun, east of Tulcán, Cordillera Oriental, 11,500 ft. alt., Oct. 15, 1943, *Steere 8100, 8101;* 9000 ft. alt., Oct. 16, 1943, *Steere 8106*. PROV. IMBABURA: In abandoned clearing above Colonia Buenos Aires, trail from Ibarra, Cordillera Occidental, 8000 ft. alt., Dec. 15, 1943, *Steere 8202*. PROV. LEÓN: On shaded bank, north side Río Macuchi, at Esperanza, Cordillera Occidental, 5200 ft. alt., Sept. 8, 1943, *Steere 8076*. PROV. ORIENTE: On bank of Río Estancias near junction with Río Pastaza, region of El Topo, Cordillera Oriental, 4400 ft. alt., May 7, 1944, *Steere & Camp 8244*.

RELBUNIUM NITIDUM (HBK.) Schum. PROV. NAPO-PASTAZA: In trail near Hacienda Macarenas, valley of Río Chingual east of El Pun, Cordillera Oriental, 9000 ft. alt., July 29, 1943, *Steere 8001*. PROV. PICHINCHA: Páramo above Chillogallo, south slope of Volcán de Pichincha, Cordillera Occidental, 11,300 ft. alt., May 20, 1944, *Steere & Camp 8320*. The first specimen cited here extends the range in Ecuador considerably; the second comes from the general type locality.

RONDELETIA TRICHOTOMA Standl. PROV. ORIENTE: At edge of forest, high ridge between El Topo and Baños, 6000 ft. alt., May 10, 1943, *Steere & Camp 8275*. Since this specimen was collected in full view of the snows of Volcán de Tungurahua, it may be considered as being from the general type locality.

RUDGEA CORNIFOLIA (H. & B.) Standl. [*R. fimbriata* (Benth.) Standl.] PROV. ORIENTE: In dense, wet forest, valley of Río Pastaza, region of El Topo, Cordillera Oriental, 4400 ft. alt., May 4, 1944, *Steere & Camp 8235*. Previously reported only from coastal Ecuador.

SABICEA PARAENSIS (Schum.) Wernham. PROV. ORIENTE: In forest at Shell-Mera, foothills of Cordillera Oriental, 3500 ft. alt., May 11, 1944, *Steere & Camp 8278;* On bank just west of Puyo, trail to Shell-Mera, 3000 ft. alt., May 12, 1944, *Steere & Camp 8298*. An Amazonian and Peruvian species which has not previously been collected in Ecuador, to my knowledge.

SABICEA VILLOSA R. & S. PROV. IMBABURA: In forest along Río Mira, near junction with Río Lita, Cordillera Occidental, 2000 ft. alt., Nov. 22, 1943, *Steere 8216*. PROV. ORIENTE: Bank of Río Estancias near junction with Río Pastaza, region of El Topo, Cordillera Oriental, 4400 ft. alt., May 7, 1944, *Steere & Camp 8246;* In forest, Shell-Mera, foothills of Cordillera Oriental, 3500 ft. alt., May 11, 1944, *Steere & Camp 8277*. Previously known in Ecuador only from the western slopes.

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"EUPHORBIA CHAMAESYCE" IN THE UNITED STATES

LEON CROIZAT

The very name of *Euphorbia Chamaesyce* L.[1] has been practically unknown to American taxonomists until the publication of Wheeler's recent monograph on *Euphorbia* L. subg. *Chamaesyce*. In this work Wheeler records this species for eleven States ranging from Massachusetts to Arizona (Rhodora **43**: 265. 1941), and offers the following elucidation (p. 269, 270), "Customarily the name *E. Chamaesyce* is applied to an entity native in the Mediterranean region and eastward into Asia. . . . There seems to be only one author, Swartz, Obs. Bot. Pl. Ind. Occ. 196. 1791, who has applied the name to any New World plant and this was ignored as a mere casual misapplication. However, while browsing through the specimens at the Field Museum, Chicago, in Sept., 1939, I came upon a photograph of the specimen in the Linnaean herbarium and fragments from the same specimen. . . . There is no doubt that *E. Chamaesyce*, as represented in the Linnaean herbarium, is identical with *E. prostrata* as usually interpreted. . . . One of the fundamental rules to be followed in the typification of a Linnaean species is that the Linnaean specimen is to be taken as type, except in extraordinary cases, if he had it in his herbarium at the time the species in question was published and if it conforms to his diagnosis. Exceptional cases are rare and require a full and elaborate explanation to establish acceptable grounds for refusing to accept the Linnaean specimen as type." On the strength of these findings and opinions, Wheeler treats as *E. Chamaesyce* L. Sp. Pl. **1**: 455 (1753) the entity commonly known as *E. prostrata* Ait. Hort. Kew. **2**: 139 (1789), stating: TYPE [of *E. Chamaesyce*]: Jamaica, *P. Browne* (Linnaean Herb. . . .) . . . TYPE [of *E. prostrata*]: "*Nat(ive)* of the West Indies. *Cult.* 1758, by Mr. Philip Miller" (British Museum if extant).

The purpose of these brief notes is to furnish the "full and elaborate explanation" which establishes the fact that the interpretation advanced in the quoted text is unacceptable, and must be rejected. Whether the Chicagoan fragment seen by Wheeler is authentic or not this writer does not profess to know.

The name *E. Chamaesyce* has universally been applied from 1753 to 1941 to an entity native to Europe, Africa and Western Asia. Likewise, the name *E. prostrata* has been generally given between 1862 and 1941 to a pandemic

[1] The species in this affinity are treated by the writer under *Chamaesyce* S. F. Gray emend. Croiz., as a distinct genus. To avoid unnecessary nomenclatural burdens in this brief comment, they are being referred here as *Euphorbia*.

tropical and subtropical weed. In the span of time mentioned these two entities have been taken up, in their classic sense, by thousands of authors, and have found their way into *tens of thousands* of publications. Lest this writer be suspected of exaggeration in speaking of tens of thousands of records, the reader may here be reminded of the fact that *every contribution* concerned with the plants of Europe, Africa, Asia, Oceania and America has used these two binomials in their traditional application, the exceptions being perhaps to be counted on the fingers of one hand to 1941.

If Wheeler's understanding of *E. Chamaesyce* and *E. prostrata* comes to pass, everyone of these records is automatically turned into a misapplication and falls into synonymy. The practical task that is to face the coming monographer of *Euphorbia* and its segregates in unravelling this fabulous synonymy is better left without comment. It is to be taken for certain that everybody in Europe, Africa, and Asia will continue to abide by the traditional applications of *E. Chamaesyce* and *E. prostrata* either by choice or necessity. Since it is not impossible that Wheeler's interpretation, on the other hand, finds its way into standard works on this side of the Atlantic, where *E. Chamaesyce* is unknown and *E. prostrata* not very well known, the net result of the shift in the concepts will be the creation of a double standard of nomenclature, the Old World understanding something and the New World something else whenever these two binomials happen to be used. In addition, the most knotty problems of nomenclature will have to be tackled and solved to everybody's satisfaction to decide what is to be proper name for the plant formerly known as *E. Chamaesyce,* and correctly to place its numerous trinomials. Looked at from every angle, an alteration of the classical application of *E. Chamaesyce* and *E. prostrata* can lead only to years of strife, disorder and confusion. It is clear, consequently that practical considerations of the most forceful nature forbid this alteration.

However, given certain conditions changes in existing names must be made. These conditions are satisfied, unquestionably, when current names conflict with the *International Rules of Botanical Nomenclature.* Not so long ago this writer has been forced to reinstate a practically unknown binomial, *E. Milii* Ch.-des-Moul. (Jour. Arnold Arb. **21**: 506. 1940), this taking the place of the ubiquitous and universally known *E. splendens* Boj. ex Hooker. The issue, then, must be faced whether the *Rules* actually forbid maintenance of the traditional concepts of *E. Chamaesyce* and *E. prostrata.* If they do, these two binomials must go, regardless of the practical consequences entailed in their rejection.

It is customary among sound taxonomists not to disturb existing nomenclature so long as changes can be avoided. It is customary, likewise, to honor the decisions of earlier authors whenever these decisions cannot be shown to be absolutely untenable. Convenience is best served by a steady nomencla-

ture and by the assurance that one author begins his work where another lays it down. Custom and convenience in this respect are sanctioned and upheld by the *Rules*. The *Rules* unequivocally state that fixity of nomenclature is their essential purpose [Art. 4(1), Amsterdam Rules, 1935], that names and forms must be rejected which throw taxonomy into confusion [Art. 4(2)], that existing names cannot be altered unless condemned by the *Rules* and shown to be manifestly untenable (Art. 17). A violation of these dicta, as is well known (Art. 2), entails illegitimacy, and cannot become the source of acceptable nomenclature. The *Rules* go so far as to give the right to an author to choose as valid either one of two or more binomials contemporaneously published (Art. 56), binding later authors to follow him. Likewise, the *Rules* admit that a straight misapplication can be maintained if it involves a generic name long in use, witness the maintenance of *Podocarpus* in the misapplied sense of Richard,[2] and of *Alpinia* Roxb. non L., *Protea* R. Br. non L. and *Banksia* L. f. non Forst., as Rehder (in Kew Bull. 344. 1935) has very pertinently pointed out.

The proponents of the old American Codes were much concerned with the proper choice of types and attempted to regulate it. Their conclusions, however, failed to win the approval of the International Congresses and were not received in the current *Rules*, which, if with some reserve, is a matter for gratification. The critical elaboration of nomenclatural tangles and controversial typifications often gives rise to questions that are incredibly involved, and it is but fair that a well-informed monographer or student should be allowed to select a type which best suits the needs of the case. Such selection, naturally, cannot conflict with the essential tenets of the *Rules*. Article 18 of the current *Rules* merely states that a specimen, description, or figure can serve as a type, it being otherwise well understood that no specimen, description, or figure shall be chosen which, without absolute need, subverts existing nomenclature and throws taxonomy into confusion.

With reference to sound usage and to the dicta of the *Rules*, therefore, it may be affirmed in the strongest terms that no author is bound to choose as the type of the name an entity (specimen, description, or figure) which leads him to violate the *Rules* by needlessly disturbing nomenclature. Nothing in the *Rules* enthrones a specimen in a position of privilege and power such as to wreck nomenclature. The type is not a pure abstraction but a means to an end. That type is to be chosen in every case which, be it specimen, description, or figure, protects stability of nomenclature and sanctions long usage.

Any author familiar with the species of *Euphorbia* of Linnaeus knows that in general these concepts are tainted with confusion and marred often-

[2] See for a discussion Pilger in Engl. Pflanzenr. 4[5]: 54 footn. 1903. This discussion fails to cover all the details of the case, but Pilger's proposals were accepted by the Congress of Vienna in 1905.

times by inept compilation. It is certainly convenient to abide by the Linnaean specimens whenever these specimens materially help in establishing the application of the Linnaean binomial, but it would be idle to speak of the Linnaean specimens as "types" in the modern sense. To dispose of a Linnaean species of *Euphorbia* it is necessary to take into account the current application of the name, its synonyms, its historical background and its specimens. All these elements must carefully be blended within a critical and broad approach.

Euphorbia Chamaesyce of the Linnaean synonyms and herbarium is a mixture of several entities which, in theory, it should be possible to reject as a *nomen confusum*. This mixture, however, has been in use for almost two centuries in a certain definite sense, and it is just as unwise to reject it as it is to alter its meaning. Not only the name must be saved, if at all possible, but its current application as well.

To a greater extent than the *Species Plantarum* (1753), the *Hortus Cliffortianus* (1737) actually reveals the taxonomic stuff of which the Linnaean thought is made. In the *Hortus Cliffortianus*, p. 198, Linnaeus treats the *Euphorbia No. 12* (later to become *E. Chamaesyce*), as constituted of two entities. The first, which is the typic form, is referred to synonyms of Morison, Tournefort, Boerhaave, Caesalpinius, Bauhin, Clusius, Dalechampius, and Dodoens, which invariably apply to the plant known as *E. Chamaesyce* to traditional taxonomy. Only one synonym involves another entity, Sloane's "Chamaesyce" (Cat. Pl. Jam. 83. 1696) from Jamaica, of which Sloane tells us: "In locis aridioribus arenosis circa urbem *St. Jago de la Vega* nihil frequentius reperitur." This entity Fawcett & Rendle identify (Fl. Jam. **4**: 342. 1920) as *E. thymifolia* L., a binomial which is as yet of very uncertain application. The variety is based on synonyms of Tournefort, Boerhaave, Morison, and Burman: it is evidently a pubescent entity, and in the main the same, it seems, as that which has been treated most commonly as *E. Chamaesyce* var. *canescens*. Linnaeus gives the following distribution: "*Crescit in agris & vineis aridis & arenosis* Siciliae, Italiae, Galliae Narbonensis & Jamaicae . . . ," adding: "Folia in Europaea magis orbiculata, in Americana oblonga & saepius macula fusca medio notata." Evidently, Linnaeus had a none too clear concept of the limits of this entity nor of its variety, and had seen European together with American material. Whether he correctly understood Sloane's plant is doubtful; Sloane himself had given for his "Chamaesyce" the usual references that apply to the weed of Europe, and on this ground Linnaeus had reason to admit it in his synonymy. It is clear at any rate that Linnaeus based his concept almost wholly on the plant of Europe, including American and Asiatic material under a mistaken assumption of range.

In the *Species Plantarum*, p. 455, the treatment is even less satisfactory.

No variety is admitted, the so-called *Dissertatio Euphorbiarum* is cited for the diagnostic phrase, as usual, and only synonyms of Linnaeus himself ("Hort. cliff. 198"), of Van Royen, Gmelin, Bauhin, and Clusius are introduced. The range this time is restricted to the Old World: "*Habitat in* Europa *australi*, Sibiria." The Siberian entity is apparently *E. humifusa* Willd., or forms in its immediate vicinity. The bulk of the synonymy, however, both direct and implied, again applies to the European plant, the references to Bauhin and Clusius being maintained throughout between 1737 and 1753.

It will be seen that not a single one of the Linnaean references has anything to do with the works of Browne, this for the very simple reason that these works had not as yet come out of the press. It is strange, to say the least, that a specimen of Browne should be the "type" of *E. Chamaesyce* under these circumstances. Does the Linnaean diagnosis and range conform with the Browne collection which allegedly typifies the name? Not unequivocally so far as this writer can see.

A work of great relevancy, but almost invariably overlooked, is Crantz's *Institutiones Rei Herbariae*, published in 1766, only thirteen years after the release from the press of Linnaeus's *Species*. Crantz usually makes the Linnaean diagnoses his own with few changes, and refers them to one or two synonyms only, which are often critically chosen. Of *E. Chamaesyce* L. Crantz says (op. cit. **2**: 457): "Euphorbia dichotoma, foliis crenulatis subrotundis glabris, floribus solitariis axillaribus, caulibus procumbentibus." which with the single addition of "glabris" repeats the characterization of the *Species Plantarum* of Linnaeus. This addition is significant. Only one synonym is listed by Crantz, "Chamaesyce. Clus. II. p. 187." This synonym appears both in the *Hortus Cliffortianus* and in the *Species Plantarum*.

Crantz's interpretation of *E. Chamaesyce* is quite acceptable under the current rules of nomenclature, for it basically agrees with the Linnaean concept of the species on the whole, with its characters and its synonyms. It has therefore the unequivocal status of a *descriptio emendata* effecting a clean-cut typification of the binomial. This amended description and this typification effected in 1766 and true to the traditional concept of the species between 1753 and 1941 cannot be lightly overthrown in 1941 to refer to a specimen of Browne, when Linnaeus does not cite the works of Browne and maintains, both in the *Hortus Cliffortianus* and in the *Species*, that *E. Chamaesyce* is a species of Southern Europe, at least *pro maxima parte*.

Clusius's characterization of "Chamaesyce" is definite, for he illustrates the plant and says (Rar. Pl. Hist. **6**: clxxxvii, *f.* 1601): "Copiosa ubiq; agro Salmanticensi, squallidis & petrosis locis, atque etiam inter ipsa vineta (quemadmodum & circa Monspelium) & plerisque alijs Hispaniae locis." This is *E. Chamaesyce* of the traditional concept, which grows in the stony

and waste grounds and in the vineyards of Salamanca in Spain, and Montpellier in Southern France. Clusius even gives the vernacular name current in Salamanca, "Nogueruela," explaining that this alludes to the shape of the seed.

In conclusion: *E. Chamaesyce* was rigorously interpreted and fully typified by Crantz in 1766, and this typification, knowingly or otherwise, has been used by thousands of authors throughout almost two centuries. Neither the *Rules* nor accepted usage make it necessary to reject Crantz's conclusions, belatedly taking up as the "type" of *E. Chamaesyce* a specimen which, chosen in the name of a hollow technicality, only serves to inflict untold damage upon classification. To use this specimen for subversive and confusing ends is a direct violation of Art. 4 and Art. 17 of the *Rules*, which plainly means that this use is illegitimate.

A fitting type of *E. Chamaesyce* is the reference to Clusius, a reference constantly upheld by Linnaeus and made by Crantz the base of a formal interpretation which has in its favor, everything else set aside, two centuries of constant usage. The application of *E. prostrata* may still be discussed. Nothing in the original publication rules out the plant so understood, but anyone who so wishes may claim that Aiton's binomial is a *nomen dubium* or a *nomen ambiguum*, and reinstate *E. callitrichoides* H.B.K. Conservative taxonomists will accept Boissier's interpretation [in DC. Prodr. **15**(2): 47. 1862; Ic. Euph. 12. *pl. 17.* 1866], no doubt, understanding that this interpretation validly amends and certifies Aiton's original obscure diagnosis. It will be time to change the existing usage, when and if a specimen of Aiton is found having a clear holotypic status for *E. prostrata*, this specimen proving that Boissier errs. So long as this specimen is not forthcoming, at least the presumption stands that Boissier is right.

As a formal, final conclusion the following synonymy is here affirmed: *Euphorbia prostrata* Ait. Hort. Kew. **2**: 139. 1789; cert. & emend. Boiss. in DC. Prodr. **15**(2): 47. 1862, Ic. Euph. 12. *pl. 17.* 1866; auct. univ. Syn.: *E. Chamaesyce sensu* Wheel. Rhodora **43**: 265. 1941; Contr. Gray Herb. **136**: 265. 1941; non L. Sp. Pl. 455. 1753, cert. & emend. Crantz Inst. Rei Herb. **2**: 457. 1766; Boiss. in DC. Prodr. **15**(2): 34. 1862.

Euphorbia Chamaesyce L. in its correct traditional application is to be excluded from our flora. It may appear among us as a ballast plant, but this writer so far has not seen it.

THE ARNOLD ARBORETUM
JAMAICA PLAIN, MASSACHUSETTS

NOTE: While this article was in press, a study appeared (Darwiniana **6**: 179–191. 1943) in which this writer dealt with the typification of *Euphorbia portulacoides* L. In that study clean-cut opinions were expressed (see op. cit. 183, and l.c. footnote, in particular) in unison with the ones voiced here. Unfortunately, in the "English Summary"

personally contributed by this writer a vital "not" was omitted on account of a typographic error, which this writer had no chance to correct. The summary in question recites in part (p. 190), "The author points out that the current International Rules of Nomenclature do bind a taxonomist to select as the type of a species a specimen rather than a description or figure." The awkwardness of this statement is evident on purely grammatical grounds. It reads as originally conceived and submitted to the editors, "The author points out that the current International Rules of Nomenclature do NOT bind a taxonomist to select as the type of a species a specimen rather than a description or figure." It is a matter of regret that the otherwise faithful Spanish summary, having been made directly from the English, reiterates the same error. It ought to read, "El autor sostiene que las Reglas ..... NO obligan ....."

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THE GENUS CNIDOSCOLUS IN MEXICO: NEW SPECIES AND CRITICAL NOTES*

CYRUS LONGWORTH LUNDELL

In carrying out investigations for the Rubber Development Corporation of the United States Government in Mexico in 1943 to determine the sources of chilte gum, collections of *Cnidoscolus* were made in eleven states. The areas in which material was gathered range from seashore, arid and wet lowlands, through wet temperate uplands, to desert and mountainous regions of the high plateau.

Although the genus is of considerable economic importance and abundantly represented throughout Mexico, it has received very little attention from botanical collectors. Considering the investiture of stinging hairs on the plants, those of *C. elasticus* causing persistent sores, this is readily understood. Further, the fleshy nature of the thick twigs demands artificial heating to dry satisfactory specimens. Staminate and pistillate flowers as well as mature seeds are essential for the interpretation of the species, and only by making several trips to each area during the season can such material be obtained. Most of the material in herbaria is grossly inadequate.

In this preliminary study, twelve new species are proposed, all apparently referable to the Section *Calyptrosolen* as delimited by McVaugh (1944). Along with field notes and other observations on various species, the transfer of *Jatropha Jurgensenii* Brig. and *J. Liebmannii* Muell. Arg. is made to the genus *Cnidoscolus*.

CNIDOSCOLUS ACONITIFOLIUS (Mill.) I. M. Johnst. Contr. Gray Herb. **68**: 86. 1923. *Jatropha aconitifolia* Mill. Gard. Dict. ed. 8. *Jatropha* No. 6. 1768.

MEXICO: VERA CRUZ, east of Córdoba, along roadside at base of cliff, October 5, 1943, *C. L. Lundell & Amelia A. Lundell 12530, 12530A*, shrub, 6 ft. high, pith with transverse plates, latex white, calyx greenish outside, white within.

This collection agrees closely with the description of the species by Pax (1910). However, the staminate calyx is minutely puberulent rather than glabrous, and the ovary is only sparsely pubescent at base.

In the interpretation of *C. aconitifolius* by McVaugh (1943), the outer stamens are described as 4–5 mm. long. In *Lundell & Lundell 12530*, the outer stamens do not exceed 3 mm. including the fused basal part (1 mm.) of filaments. The staminate and pistillate flowers are slightly less than 1 cm. in length. The seeds from *Lundell & Lundell 12530A* agree in detail with the illustration by McVaugh (1943, fig. 12) based upon *Rose & Rose 11474*.

C. tenuilobus, described from the Pacific lowlands, approaches *C. aconitifolius*, as herein interpreted, and represents a geographical segregate. The

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androecium of both species is very similar, differing only in the smaller size of the gland in *C. aconitifolius*. In both species the staminate calyx lobes are shorter than the tube.

Cnidoscolus albidus Lundell, sp. nov. Frutex, 1 m. altus, pilosus et dense stimulosus. Folia longe petiolata, petiolo ad 15 cm. longo; lamina late cordata, 7.5–17 cm. longa, 9.5–21 cm. lata, supra pilosa, subtus albido-tomentosa, lobis 5, grosse lobulato-dentatis. Flores foeminei 9–11 mm. longi. Calyx utrinque sexus ad medium 5-lobus. Antherae biverticillatae. Ovarium pubescens.

Shrub, 1 m. high; twigs thick, densely pilose, the stinging hairs abundant, up to 5 mm. long; pith drying with transverse walls. Petioles rather stout, costate, up to 15 cm. long, densely pilose, the stinging hairs abundant; gland at apex of petiole large, fleshy, horseshoe-shaped. Leaf-blades broadly cordate, 7.5–17 cm. long, 9.5–21 cm. wide, with 5 primary lobes and veins, openly but narrowly cordate at base, upper surface dark green, densely pilose, bearing scattered stinging hairs along the primary and secondary veins, under surface white-tomentose, the stinging hairs few; the primary lobes extending below the middle of the blade, each conspicuously lobed and coarsely dentate, the secondary lobes and teeth spinescent. Inflorescence 6–15 cm. across; the peduncle 16–27 cm. long, densely pilose, the stinging hairs abundant; the primary branches of the inflorescence 2–6, forked 2–4 times, up to 5.5 cm. long, ascending, densely pilose and conspicuously armed with abundant stinging hairs, the ultimate branchlets bearing staminate flowers. Staminate flowers white; calyx finely tomentose, 15–17 mm. long, the tube slender, contracted at base into a short stipe, expanded above, obscurely costate, lobed to the middle, the lobes elliptic, spreading; staminal column pubescent at base, the stamens exserted; stamens 10 in two whorls; anthers 1.5–2 mm. long, equaling or slightly longer than the free part of filaments; staminodia 3, filiform, erect. Pistillate flowers solitary; calyx finely tomentose, deciduous in one piece, 9–11 mm. long, the tube cylindrical, the lobes oblong-elliptic, armed with a few stinging hairs; ovary finely tomentose; styles 3, dichotomously forked. Immature capsule ellipsoid, tomentose with fine short hairs, not beset with stinging hairs.

MEXICO: HIDALGO, above Jacala, off highway at kilometer 270, in scrub, August 19, 1943, *C. L. Lundell & Amelia A. Lundell 12394* (TYPE in the herbarium of Southern Methodist University).

Since the pistillate calyx is tubular at the base and deciduous as a whole, *C. albidus* is technically near *C. tubulosus* (Muell. Arg.) I. M. Johnst. As usually interpreted, *C. tubulosus* has been a nebulous entity to which most species with pistillate calyx tubular at base have been referred. Since type material is not available for examination, I am uncertain as to the application of the name. Pax (1910) described the staminate calyx of *C. tubulosus* as follows: "Calyx ♂ aperiens pyriformis, 5 mm. longus, deinde 6–8 mm. attingens, extus tomentellus." *C. elasticus, C. tepiquensis, C. spinosus,* and *C. albidus,* referable to this complex, all have the staminate calyx at least twice as large, and differ broadly in various other significant characteristics.

C. albidus is scarcely to be confused with any other Mexican species. Like *C. armatus,* it is a desert shrub of the high plateau.

Cnidoscolus armatus Lundell, sp. nov. Frutex, ad 1.5 m. altus, armatus. Folia petiolata, petiolo ad 8 cm. longo; lamina parva, rigide chartacea, ad

10.5 cm. longa, 11 cm. lata, ad basim villosa, glabrata, lobis 3 vel 5, lobulatis, remote dentatis. Inflorescentiae 3–7 cm. latae. Capsula ca. 11 mm. longa, glabrata, stimulosa. Caruncula 3–3.6 mm. lata.

Shrub, up to 1.5 m. high, the branches viciously armed with persistent rigid stinging hairs up to 1.3 cm. long; twigs stout, reddish, villous at the tips, conspicuously armed; pith with transverse plates. Petioles stout, costate, up to 8 cm. long, brown-villous along the lower side and at apex and base, the stinging hairs few; gland at apex of petiole small and fleshy, or absent. Leaf-blades small, drying stiff and chartaceous, up to 10.5 cm. long (from apex of petiole), up to 11 cm. wide, the basal sinus narrow, the primary lobes and veins 3 or 5, brown-villous at base, essentially glabrous otherwise, the stinging hairs few on both surfaces, appressed along the margin; the lobes extending at least three-fourths to base, narrowed below, the apical largest, the basal reduced and spreading, the apical and lateral usually with a prominent secondary lobe on each side at or above the middle, the margin remotely dentate with sharp teeth, the teeth gland-tipped. Inflorescence (in fruit) small, 3–7 cm. across, the peduncle stout, up to 10 cm. long, short villous-tomentose at first, glabrate, beset with stinging hairs; the primary branches 2 or 3, forked, with indument like that of peduncle. Staminate and pistillate flowers not seen. Capsules oval, about 11 mm. long (almost mature), glabrate, beset with slender stinging hairs. Seeds gray, not mottled, or with a few minute black spots chiefly along the margin, oblong-ellipsoid, somewhat flattened, about 9 mm. long (including the protruding caruncle), 5 mm. wide, slightly emarginate at base, acutish at apex; caruncle large, fleshy, protruding beyond apex of seed, 3–3.6 mm. wide, 1.6–1.9 mm. high, subtruncate and lobed at base, extending below the hilum, the fleshy lobes forming a cavity above the depressed hilum.

MEXICO: PUEBLA, off Tehuacán-Córdoba road, on dry hills east of Garci-Crespo, in desert scrub, October 5, 1943, *C. L. Lundell & Amelia A. Lundell 12525* (TYPE in the herbarium of Southern Methodist University).

In the absence of flowers, the relationship cannot be established; however, the leaf form is suggestive of *C. aconitifolius*. The species is exceptionally well-marked by the abundant long rigid stinging hairs persistent on the branches, by the gland-tipped hairs of the leaf margin, by the small seeds with protruding fleshy caruncle forming a cavity around the hilum, and by the small thick leaf blades. The villous indument usually is reddish. When present, the petiolar gland is small and fleshy.

Growing in the arid Tehuacán plateau region, the species appears to be isolated geographically.

Cnidoscolus Chaya Lundell, sp. nov. Frutex, ca. 3 m. altus, stimulosus, ceterum glaber. Folia petiolata, petiolo 12–15 cm. longo; lamina ad 15 cm. longa, 23 cm. lata, stimulosa, lobis 7, subpinnatifidis. Sepala ♂ 12 mm. longa, ad medium connata, puberula, alba. Stamina 10, biverticillata, 11 mm. longa. Capsula ca. 1 cm. longa, parce stimulosa. Caruncula ca. 1.5 mm. lata.

Arborescent shrub, scarcely 3 m. high; twigs thick, armed with scattered spine-like stinging hairs up to 4 mm. long, glabrous otherwise. Petioles stout, 12–15 cm. long, armed with short scattered stinging hairs, rather sparsely hirtellous at apex and base, otherwise glabrous, costate when dry; glands at apex of petiole suborbicular, fleshy, paired, one above the other. Leaf-blades broader than long, up to 15 cm. long (from apex of petiole), 23 cm. wide,

with deep broad basal sinus, the primary lobes and veins usually 7, with scattered short stinging hairs along the principal veins on both surfaces, pubescent at base, otherwise glabrous; lobed to within 2–3 cm. of base of blade, the lobes pinnatified, cut at least halfway to their midribs into oblong or triangular secondary lobes as much as 6 cm. long, the apex of lobes and teeth of margin usually triangular, acute, ciliate with short appressed setae. Inflorescence small in flower, about 6 cm. across, the peduncle stout, about 24 cm. long, conspicuously armed with short stinging hairs, hirtellous at apex and base, otherwise glabrous; the primary branches of inflorescence beset with short stinging hairs, pubescent at the nodes. Staminate flowers white; calyx finely puberulent, 12 mm. long, lobed to the middle, the lobes elliptic, the tube narrow, scarcely 2 mm. in diameter, expanded above, the lobes spreading; stamens 10, in two whorls, 11 mm. long, exserted, basal 2 mm. of staminal column pubescent; lower (outer) stamens with filaments fused for 6 mm., free part of filaments 1.5–2 mm. long; upper (inner) stamens with filaments fused for about 8 mm., free part of filaments about 3 mm. long; anthers 1.5 mm. long; staminodia 2 or 3, filiform, about 4 mm. long, the tips often recurved. Pistillate flowers solitary in the forks of the branches; calyx deciduous, not seen. Young capsules glabrous, beset with scattered short stinging hairs. Capsules about 1 cm. long, beset with scattered stinging hairs. Seeds small, ellipsoid, 7 mm. long, 5 mm. wide, somewhat flattened; caruncle about 1.5 mm. wide, shriveled, subcordate at base above the small protruding hilum.

MEXICO: YUCATÁN, kilometer 27, Mérida-Progreso road, abundant in cactus thicket, July 30, 1938, *C. L. Lundell & Amelia A. Lundell 8201* (TYPE in the herbarium of Southern Methodist University); vernacular names, *xtsaa, chaya.*

Like *C. Chayamansa*, this species appears to be allied to *C. aconitifolius.* In its paired petiolar glands it resembles *C. Chayamansa*, but differs notably from that species in the distinctive characteristics of the androecium, abundance of stinging hairs, larger staminate flowers, and spreading primary veins of leaf.

CNIDOSCOLUS CHAYAMANSA McVaugh, Bull. Torrey Club **71**: 466. 1944.

BRITISH HONDURAS: Orange Walk District, Honey Camp, cultivated in the dooryard, September 17, 1929, *C. L. Lundell 494* (TYPE in the United States National Herbarium), a shrub 4 ft. high.

The plant, also known from Yucatan, apparently has not been found in the wild. A closely related native species is *C. Chaya,* described from Yucatan.

CNIDOSCOLUS ELASTICUS Lundell, Field & Lab. **12**: 33. 1944.

MEXICO: SINALOA, near Chele, Arroyo de la Fresa, Rancho del Pino, altitude 2800 ft., May 9, 1943, *C. L. Lundell 13021* (TYPE in the herbarium of Southern Methodist University), tree, 3 in. diameter, 22 ft. high, bark reddish, flowers white; same locality and date, *Lundell 13020*, tree, 6 in. diameter, 28 ft. high, bark papery and red, flowers white, gland at base of ovary orange; same locality, October, 1943, *C. L. Lundell & Rodolfo Gomez 12613*, tree, 6 in. diameter, 15 ft. high, capsules fleshy, ellipsoid, rostrate; road from Rancho del Pino to Copala, May 28, 1943, *C. L. Lundell & Manuel Itie 12175*, small tree, flowers white. DURANGO, Corral de Piedra, above Tayoltita, Piaxtla River, altitude 5000 ft., April 10, 1943, *Lundell 13001*, tree, 12 in.

diameter, 30 ft. high, bark thin, papery and reddish, staminate flowers white and fragrant; La Joya Mountain (or La Cruz Larga), above Corral de Piedra, Piaxtla River, altitude 5000 ft., April 11, 1943, *Lundell 13008*, tree, 6 in. diameter, 15 ft. high, flowers white; Ojito (or Encinal), above Corral de Piedra, Piaxtla River, altitude 5000 ft., April 12, 1943, *Lundell 13009*, tree, 4 in. diameter, 12 ft. high, flowers white, latex white; Ejido Campanilla, San Felipe de las Minas, near Huajupa, San Lorenzo River watershed, on mountain side, altitude about 5200 ft., April 27, 1943, *Lundell 13012*, tree, 6 in. diameter, flowers white; same locality and date, *Lundell 13013*, small tree, flowers white; below Otaes, on trail to Huajupa, April 26, 1943, *Lundell 13080*, seeds collected in that vicinity by Indians during the previous season; Rancho de la Mina, west of Los Remedios, April 15, 1943, *H. S. Gentry 6820*, reddish barked tree, 18 to 21 ft. high, with blunt twigs, leafless. TEXAS: Dallas County, Agricultural Research Station, near Renner, September 9, 1944, *Lundell 13302*, seedlings six months old grown from seeds obtained in Durango, Mexico.

On March 17, 1944, seeds of *C. elasticus*, obtained at Otaes in the interior mountains of Durango, were planted at the Agricultural Research Station of the Institute of Technology and Plant Industry. In the test plot, the germination of seeds planted in the field was approximately 90 per cent. After a slow start, the seedlings began to grow rapidly in August and September. In September three of the plants flowered. By the middle of November, 1944, at an age of eight months, the seedlings had reached a maximum height of six feet and a diameter up to two inches at the base, a remarkable rate of growth.

The heavy frost of November 27, 1944, at Dallas, when the temperature dropped to 29° F, killed the leaves and tender growth. On the same date there was considerable damage to the cortex for latex oozed out over the stem to coagulate into small scattered lumps. Subsequent temperatures as low as 20° F killed all of the stem except the woody base. Although the roots and base survived a temperature of 20° F, the critical temperature for the species is about 30° F, and no commercial plantings should be made where heavy frosts occur.

The plantation possibilities of *C. elasticus* are the subject of current investigations. The gum from the tree is considered by the chewing gum industry to be a satisfactory substitute for jelutong, formerly imported from the Far East. Intensive exploitation of the wild stand in Durango and Sinaloa is underway.

C. elasticus and the closely related *C. tepiquensis*, the two rubber-yielding species, both have solid pith. In all other members of the Section *Calyptrosolen*, the pith has transverse plates when dry. These differences are of possible subsectional importance.

Cnidoscolus Hernandezii Lundell, sp. nov. Frutex, pilosus et dense stimulosus. Folia petiolata, petiolo ad 16 cm. longo, eglanduloso; lamina ad

13.5 cm. longa, 18 cm. lata, cordata, pilosa, lobis 5, remote dentatis. Inflorescentiae ad 14 cm. latae, pilosae et stimulosae. Capsula ca. 1.2 cm. longa, glabra. Caruncula 2.5–2.8 mm. lata.

Shrub with thick branches; twigs very stout, armed with abundant amber colored stinging hairs up to 6 mm. long, pilose with short hairs; pith drying with transverse plates. Petioles stout, up to 16 cm. long, pilose, armed with scattered stinging hairs; eglandular at apex of petiole. Leaf-blades broader than long, up to 13.5 cm. long, 18 cm. wide, the basal sinus deep, narrow, rounded, the primary lobes and veins usually 5, pilose on both surfaces, the hairs dense along the principal veins, with scattered stinging hairs on upper surface and along margin; the primary lobes extending to middle of blade, oblong-elliptic or obovate-elliptic, the margin of lobes rather remotely dentate with acuminate teeth 2–10 mm. long, the teeth on margin of apical 3 lobes minute below, large above the middle. Inflorescence (in fruit) rather large, up to 14 cm. wide, the peduncle rather slender, up to 23.5 cm. long, densely pilose and conspicuously armed with stinging hairs; the primary branches of the inflorescence usually 2 or 3, forked, covered with indument like that of peduncle. Staminate and pistillate flowers not seen. Ovary pubescent at apex and base, otherwise glabrous; style pubescent. Capsule oval, depressed at apex, about 1.2 cm. long, glabrous. Seeds oblong-ellipsoid, somewhat flattened, 8.5–9 mm. long, about 5.5 mm. wide, mottled at maturity primarily along margin, acutish at apex; caruncle fleshy, yellowish, 2.5–2.8 mm. wide, subtruncate or rounded, with two small fleshy lobes at base on each side of the small hilum, crested medianally above the hilum.

MEXICO: OAXACA, Santa María del Tule, October 17, 1943, *Efraim Hernandez X. s. n.* (TYPE in the herbarium of Southern Methodist University); vernacular name, *mala mujer*.

C. Hernandezii is anomalous in that the petioles are eglandular at apex. The pilose twigs, leaves and inflorescences, abundant short amber colored stinging hairs, essentially glabrous ovary, and distinctive small seeds with crested caruncle bilobulate at the subtruncate base are distinguishing characteristics. In the absence of flowers, its affinities are uncertain.

Cnidoscolus Jurgensenii (Briq.) Lundell, comb. nov. *Jatropha Jurgensenii* Briq. Ann. Cons. Jard. Bot. Genève **4**: 229. 1900.

Cnidoscolus Liebmannii (Muell. Arg.) Lundell, comb. nov. *Jatropha Liebmannii* Muell. Arg. Linnaea **34**: 212. 1865.

No specimens have been seen which may be referred to this species, and a study of the type is essential to definitely determine its status. As described, the laciniate lobes of the leaves, the glabrous staminal tube, combined with a pistillate calyx tubular to the middle indicate that a distinct species is represented.

Cnidoscolus macrandrus Lundell, sp. nov. Frutex, parce stimulosus. Folia petiolata, petiolo ad 13 cm. longo; lamina membranacea, ad 15 cm. longa, 22 cm. lata, cordata, parce stimulosa, glabrata, lobis 5 vel 7, cuspidato-acuminatis, remote dentatis. Inflorescentiae parvae, ad 8 cm. longae. Sepala ♂ 15–16 mm. longa, ad medium connata. Stamina 10, biverticillata, 8 mm. longa. Antherae 3 mm. longae, 2 mm. latae.

Shrub; twigs stout, with a few short stinging hairs at apex only, sparsely pubescent at the nodes, glabrate; pith with transverse plates. Petioles cos-

tate, up to 13 cm. long, sparsely pubescent at first with subappressed hairs, glabrate, unarmed or beset with few short stinging hairs; gland at apex of petiole fleshy, slightly elevated. Leaf-blades very thin, broader than long, up to 15 cm. long (from apex of petiole), up to 22 cm. wide, the basal sinus open and rounded, the primary lobes and veins 5 or 7, with scattered small stinging hairs on upper surface and along margin at first, pubescent at base on both surfaces, glabrate, the margin ciliate with appressed hairs, otherwise glabrous; lobed at least three-fourths to base of blade, the lobes oblanceolate, cuspidate-acuminate, the margin of lobes dentate with small acute and larger acuminate teeth, without conspicuous secondary lobes. Inflorescence small, up to 8 cm. long, 4–5 cm. wide, the peduncle slender, up to 6 cm. long, sparsely pubescent, beset above middle with short stinging hairs; the primary branches of inflorescence 2 or 3, forked, pubescent and beset with scattered stinging hairs. Pistillate flowers and fruits not seen. Staminate flowers white; calyx sparsely pubescent, the buds obovate, the mature calyx 15–16 mm. long, short-stipitate at base, campanulate, the tube wide, lobed to the middle, the lobes up to 7 mm. long, 6 mm. wide, elliptic. Stamens 10, in two whorls, 8 mm. long, villous at base of staminal column; the gland lobed, thick; lower (outer) stamens with filaments fused 2–2.5 mm., free part of filaments about 3 mm. long; upper (inner) stamens with filaments fused for about 4 mm., free part of filaments about 3 mm. long; anthers 3 mm. long, 2 mm. wide; staminodia 3, filiform, about 4 mm. long.

MEXICO: VERA CRUZ, between Jesus Carranza and Suchilapan, altitude 200 ft., along edge of trail in wet lowland forest, January 24, 1943, *C. L. Gilly, Sr. 4713* (TYPE in the herbarium of Southern Methodist University).

The reduced inflorescence, small leaves, large staminate flowers, large anthers, and the peculiarities of the staminal column set this species apart.

CNIDOSCOLUS MULTILOBUS (Pax) I. M. Johnst. Contr. Gray Herb. **68**: 86. 1923. *Jatropha multiloba* Pax, Pflanzenreich IV. **147**: 107. 1910.

MEXICO: SAN LUIS POTOSÍ, El Banito, near Valles, July 14, 1943, *C. L. Lundell & Amelia A. Lundell 12244*, a shrub or tree, up to 6 in. diameter, 20 ft. high, latex white, calyx white; Tamazunchale, along rocky ravine off highway to Chapulhuacan, July 15, 1943, *Lundell & Lundell 12260*, low shrub, almost glabrous, viscid; same locality and date, *Lundell & Lundell 12261*, arborescent shrub, calyx white.

The type of *C. multilobus*, *Bourgeau 2231* from Orizaba, Vera Cruz, is not available, and no authentic specimens of the species have been seen. That collections representing a series of closely related species are now being pigeon-holed under this name appears probable.

The collections from San Luis Potosí are being referred to *C. multilobus* tentatively. The seeds of *Lundell & Lundell 12244* have the same caruncle as illustrated by McVaugh (1943, fig. 13). *Lundell & Lundell 12260* is anomalous in that the leaves are viscid when fresh, a condition not noted in any other collection. The leaf-blades of *Lundell & Lundell 12244* and *12261* are velutinous. In all three collections, the apex of the petiole bears two mammaeform fleshy glands.

Of the new species proposed, *C. macrandrus*, *C. parviflorus*, and *C. velutinus* belong to the *C. multilobus* complex.

Cnidoscolus orbiculatus Lundell, sp. nov. Herbacea, ad 1 m. alta, caulis dense stimulosus. Folia petiolata, petiolo 1.5–8.5 cm. longo, stimuloso, supra

villoso; lamina orbiculata, ad 9 cm. longa, 14.5 cm. lata, profunde cordata, stimulosa, supra parce villosa, subtus parce hispida, lobis 3, grosse sinuato-dentatis. Inflorescentiae foliis breviores, 1.5–3, raro ad 5 cm. longae, stimulosae. Sepala ♂ stimulosa, 12–13 mm. longa, ad medium connata. Stamina 10, biverticillata. Sepala ♀ 9–11 mm. longa, stimulosa. Capsula ca. 1.4 cm. longa, rostrata. Caruncula 3 mm. lata.

Perennial herb up to 1 m. high, bushy; stems stout, densely armed with slender stinging hairs up to 11 mm. long; twigs comparatively slender, densely covered with stinging hairs of various lengths, pubescent at the nodes, glabrous otherwise. Petioles rather slender, costate, 1.5–8.5 cm. long, beset with slender stinging hairs, short villous on upper surface, otherwise glabrous; gland at apex of petiole suborbicular, large, fleshy. Leaf-blades broader than long, orbicular in outline, up to 9 cm. long (from apex of petiole), up to 14.5 cm. wide, cordate with deep open basal sinus, the primary veins usually 7, shallowly 3-lobed at apex, beset with slender stinging hairs on both surfaces, short villous at base and along primary veins on upper surface, sparsely hispid over the entire lower surface; the margin appressed hispid, coarsely sinuate-dentate, the teeth up to 1.5 cm. long, broad at base, acuminate, spinescent but not hair-like at tips. Flowers in small cymes hidden at the ends of leafy branches; inflorescence usually 1.5–3 cm. long including peduncle, rarely up to 5 cm. long with mature fruits; the peduncle and branches short villous in a single line, beset with stinging hairs, Staminate flowers white; calyx lobes beset with stinging hairs, the calyx otherwise entirely glabrous, 12–13 mm. long, the tube slender at base, gradually expanded upward, the lobes extending to the middle, elliptic; stamens 10, in two whorls, 9 mm. long, not stipitate above the gland, the basal 0.5 mm. of staminal column pubescent; lower (outer) stamens with filaments fused for 3.5 mm., free part of filaments about 1.5 mm. long, anthers about 1.5 mm. long; upper (inner) stamens with filaments fused for about 6 mm., free part of filaments about 2 mm. long, anthers about 1.5 mm. long; staminodia 1–3, about 2 mm. long, filiform. Pistillate flowers solitary in the forks of the branches; calyx 5-lobed to base, 9–11 mm. long, the lobes oblanceolate-linear, rounded at apex, beset above middle with stinging hairs, otherwise entirely glabrous. Ovary with a ring of hairs at base, otherwise glabrous, rostrate at apex, the base of style fused, styles 3, glabrous, forked. Capsules broadly oval, about 1.4 cm. long including abruptly narrowed rostrate apex, beset with scattered stinging hairs, pubescent at base, glabrous otherwise. Seeds mottled brown, oblong, 8 mm. long (including the protruding caruncle), 5 mm. wide, apex and base subtruncate; caruncle fleshy, 3 mm. wide, extending below the hilum, base broadly rounded, 2-lobed, the small hilum seated between the protruding lobes.

Mexico: Morelos, about 9 kilometers beyond Alpuyeca on Cacahuamilpa road, in fallow field and along roadside, July 31, 1943, *C. L. Lundell & Amelia A. Lundell 12312* (type in the herbarium of Southern Methodist University).

C. orbiculatus has affinity to *C. calyculatus* (Pax & Hoffm.) I. M. Johnst., *C. angustidens* Torr., and *C. Pringlei* I. M. Johnst. These herbaceous species are very closely allied, and additional field work will be necessary to obtain adequate specimens for the delimitation of the entities. In many respects, *C. orbiculatus* agrees with the description of *C. calyculatus*, but differs at

once in having fused rather than free filaments in the lower (outer) staminal series, and longer calyces glabrous except for the stinging hairs. In *C. angustidens* the inflorescence is comparatively large, the teeth of the leaves are long and slender, the seeds are larger, and the leaves are conspicuously lobed. *C. Pringlei*, known only from description, has smaller more conspicuously lobed leaves, a laxly flowered inflorescence, puberulent calyces, and smaller capsules. Noteworthy in *C. orbiculatus* is the small congested inflorescence almost concealed by the leaves.

Cnidoscolus parviflorus Lundell, sp. nov. Frutex, 2 m. altus, parce stimulosus, glabratus. Folia longe petiolata, petiolo ad 21 cm. longo; lamina ad 18 cm. longa, 22 cm. lata, profunde cordata, pilosa, lobis 3 vel 5, supra dentatis. Sepala ♂ 6.5–9 mm. longa, ad medium connata. Stamina 10, raro 6 vel 9, biverticillata, ca. 6 mm. longa. Sepala ♀ 4–4.5 mm. longa. Ovarium pubescens. Capsula 12 mm. longa. Caruncula parva, ca. 1 mm. lata.

Shrub, 2 m. high, practically unarmed; twigs rather slender, beset with scattered ascending stinging hairs scarcely 2 mm. long, short pilose, glabrate with age; pith with transverse plates. Petioles densely short pilose, usually unarmed, up to 21 cm. long; glands at apex fleshy, entire or shallowly lobed, slightly elevated. Leaf-blades slightly broader than long, up to 18 cm. long (from apex of petiole), up to 22 cm. wide, deeply cordate at base, the sinus open and rounded, the primary lobes 3 or 5, pilose on both surfaces, the hairs thinner and shorter on upper side, beset with a few small subappressed stinging hairs along margin and primary veins, otherwise unarmed; lobed to below the middle of blade, the apical lobes obovate-oblong, acuminate, the sinuses open and rounded, the margin of lobes conspicuously dentate above the middle with few acute or acuminate teeth up to 1.2 cm. long. Inflorescence small and flat, up to 6.5 cm. wide, the peduncle up to 22 cm. long, the peduncle and branches densely pubescent with soft short somewhat matted hairs, unarmed or beset with very few small stinging hairs. Staminate flowers white; calyx finely tomentose, 6.5–9 mm. long, tube subcampanulate, lobed to the middle, the lobes elliptic or suborbicular, up to 4 mm. wide, cordate at base; stamens usually 10, sometimes reduced to 6 or 9, in two whorls, about 6 mm. long, basal 1 mm. of staminal column pubescent; the staminal column 2 mm. high; lower (outer) stamens with filaments free for about 2 mm.; upper (inner) stamens with fllaments free for 3.5–4 mm.; the free part of both whorls attached to staminal column at same point; anthers about 1.5 mm. long; staminodia 1–3, filiform, up to 5.5 mm. long. Pistillate flowers solitary in the forks of the branches; calyx finely tomentose, lobed to the base, the lobes oblong, 4–4.5 mm. long; ovary densely pubescent with short hairs; styles sparsely pubescent, sessile. Capsules subglobose, about 12 mm. long, sparsely pubescent and beset with short stinging hairs, warty over the entire surface. Seeds brown, oblong-ellipsoid, slightly compressed, about 9 mm. long, 5.5 mm. wide; caruncle small, scarcely 1 mm. wide, narrowed to base above hilum, the margin curled.

MEXICO: SAN LUIS POTOSÍ, off Xilitla road, on mountain side above the Axtla River, August 21, 1943, *C. L. Lundell & Amelia A. Lundell 12427* (TYPE in the herbarium of Southern Methodist University).

C. parviflorus is near *C. multilobus*, but the smaller flowers, smaller anthers, distinctive caruncle scarcely 1 mm. wide, persistently pubescent leaves, and the almost complete absence of stinging hairs distinguish it. The

short staminal column with free filaments of both whorls attached at the same point at apex is noteworthy. In some staminate flowers there are as few as six stamens, an aberrant condition not noted among other Mexican species.

Cnidoscolus rostratus Lundell, sp. nov. Frutex, 1–2 m. altus, stimulosus et dense pilosus. Folia longe petiolata, petiolo ad 14 cm. longo; lamina cordata, 8–17 cm. longa, 6.8–17 cm. lata, velutina, lobis 3, raro 5, dentatis. Inflorescentiae parvae, pilosae et parce stimulosae. Sepala ♂ ca. 13 mm. longa, ad medium connata. Stamina 10, biverticillata. Sepala ♀ linearioblonga, ca. 9 mm. longa. Ovarium tomentosum, rostratum. Capsula rostrata.

Shrub, 1–2 m. high; branches thick, tuberculate, the tubercles covered with coarse stinging hairs; twigs stout, densely pilose and covered with coarse subappressed stinging hairs up to 7.5 mm. long; pith continuous, without dissepiments before drying. Petioles rather stout, up to 14 cm. long, densely pilose, the stinging hairs few and scattered; gland at apex of petiole large, fleshy, suborbicular to reniform. Leaf-blades cordate, 8–17 cm. long, 6.8–17 cm. wide, usually with 3, rarely 5 primary lobes and veins, the basal sinus open, subtruncate or rounded, both surfaces densely pilose (velutinous), the stinging hairs small, few and scattered on upper surface, often absent from lower surface; the primary lobes extending to the middle of the blade, the terminal one obovate, each acuminate and spinescent, the margin coarsely toothed with few acuminate spinescent teeth, these terminating the secondary veins. Inflorescence small, 3–4 cm. wide, the peduncle stout, up to 14 cm. long, densely short pilose and armed with scattered stinging hairs; the primary branches of the inflorescence usually 2 or 3, forked 1 or 2 times, densely short pilose and armed with scattered small stinging hairs. Staminate flowers white (only 1 lodged in inflorescence seen); calyx pubescent, about 13 mm. long, lobed to the middle, the lobes oblong-elliptic, spreading; staminal column stipitate above the annular gland, pubescent at base; lower stamens included, the filaments united into a tube only about 1.5 mm. long; stamens 10 in two whorls; anthers of lower (outer) ones subsessile, 2.2 mm. long; anthers of upper ones slightly smaller, exserted, the free part of filaments about 2.5 mm. long; staminodia 2, less than 1 mm. long. Pistillate flowers solitary in the forks of the branches; calyx pubescent, the lobes splitting almost to the base, about 9 mm. long, linear-oblong, beset with a few stinging hairs. Ovary tomentose, rostrate at apex, the thick base of style persistent. Immature capsules ovoid-ellipsoid, costate, conspicuously rostrate, pubescent, not armed with stinging hairs.

MEXICO: OAXACA, north of Huajuápam, on black arid limestone hills of high plateau, July 26, 1943, *C. L. Lundell 12304* (TYPE in the herbarium of Southern Methodist University).

The pistillate calyx is lobed almost to the base as evidenced by the fragmentary flowers available. Although of doubtful relationship, the species is very distinct.

Among arborescent members of the genus in Mexico, only *C. elasticus* has a rostrate capsule similar to that of *C. rostratus*. Another peculiarity of the species is the presence on older wood of tubercles densely covered with stinging hairs.

CNIDOSCOLUS SOUZAE McVaugh, Bull. Torrey Club **71**: 468. 1944.

MEXICO: CAMPECHE, Tuxpeña, in secondary growth, January 15, 1932, *C. L. Lundell 1189* (TYPE in the Gray Herbarium), a shrub. YUCATAN, near

Piste, abundant in low thicket, June 14, 1938, *C. L. Lundell & Amelia A. Lundell 7549*, a shrub, 6–12 ft. high, flowers white.

The 1938 collection from Yucatan differs slightly in having staminate flowers up to 12 mm. long, but agrees rather closely in other characteristics, notably in having the filiform stipitate glands at the apex of the petiole and the gland-tipped setae of the leaf margin.

The stipitate petiolar glands of *C. Souzae* and the substipitate mammaeform glands in *Lundell & Lundell 12244* from San Luis Potosí, referred tentatively to *C. multilobus*, suggest a relationship. Further, the leaves of *C. Souzae* are similar in form to those of *C. multilobus* and allied species. There is considerable justification for the reference of this well-marked species to the Section *Calyptrosolen*.

Cnidoscolus spinosus Lundell, sp. nov. Arbor parva ad 5 m. alta; rami crassi, stimulosi, ceterum glabri. Folia longe petiolata, petiolo ad 22.5 cm. longo; lamina 9–20 cm. longa, 12–29 cm. lata, ad basim cordata, parce stimulosa, glabrata, lobis 3 vel 5, apice rotundatis, dentatis. Inflorescentiae ad 25 cm. latae, longe pedunculatae. Sepala ♂ puberula, ca. 13 mm. longa, ad medium connata. Stamina 10, biverticillata. Sepala ♀ ca. 8 mm. longa, ad medium connata. Capsula 1 cm. longa, stimulosa. Caruncula 2.5 mm. lata, basi cordata.

Arborescent shrub or small tree up to 5 m. high; pith with transverse plates; twigs thick, armed with rigid spine-like stinging hairs up to 1.3 cm. long, glabrous otherwise. Petioles thick, up to 22.5 cm. long, puberulent at apex and base, the stinging hairs few, scattered, glabrous otherwise, drying costate; gland at apex of petiole large, fleshy, suborbicular. Leaf-blades cordate or cordate-orbicular, 9–20 cm. long, 12–29 cm. wide, with 3 or 5 primary lobes and veins, the basal sinus narrow and deep, upper surface covered at first with stinging hairs, these scattered and inconspicuous or absent at maturity, otherwise glabrous, undersurface puberulent along primary veins at base, otherwise glabrous, the stinging hairs persistent along margin of basal sinus; the primary lobes extending almost to middle of blade, the terminal and two lateral ones (in 5-lobed leaves) obovate-orbicular, the margin of lobes dentate, the teeth triangular-acuminate, up to 1 cm. long. Inflorescence large, standing out above the leaves, up to 25 cm. across, the peduncle thick, up to 45 cm. long, puberulent at apex and base, armed with long stinging hairs, otherwise glabrous; the primary branches of the inflorescence usually 3 or 4, forked up to 6 times, armed with stinging hairs. Staminate flowers white; calyx finely puberulent, about 13 mm. long including a short basal stipe, lobed to the middle, the lobes elliptic, spreading; staminal column pubescent at base, short stipitate above gland; stamens 10, in two whorls; lower stamens included in tube, the united filaments about 2 mm. long, subequal, anthers about 2.3 mm. long; upper (inner) stamens exserted, the free part of filaments about 2.5 mm. long, the anthers 2 mm. long; staminodia 3, filiform, equaling the upper stamens, about 3.5 mm. long. Pistillate flowers solitary in the forks of the branches; calyx deciduous in one piece, finely pubescent, about 8 mm. long, 5-lobed to the middle or lower, the lobes elliptic. Ovary hirtellous at apex and base, otherwise glabrous; styles 3, hirtellous, forked 3 times, spreading. Capsules broadly ellipsoid, 1 cm. long (almost mature), armed with stinging hairs, otherwise glabrous. Immature seeds oblong-ellipsoid, 8.5 mm. long, 6 mm. wide, somewhat flattened; caruncle 2.5 mm. wide, flat, cordate at base.

MEXICO: JALISCO, Municipio Puerto Vallarta, Chimo, along seashore, altitude 6–30 ft., June 8, 1943, *C. L. Lundell 13028, 13029* (TYPE in the herbarium of Southern Methodist University); vernacular name, *hiedra*.

C. spinosus is abundant along the seashore at Chimo, growing where salt spray often covers the plants. It is evidently a local endemic easily recognized by the dense investiture of stiff stinging hairs, essentially glabrous leaves with rounded lobes, and exceptionally large inflorescences. The pistillate calyx, united at base and deciduous in one piece, is typical of the small complex of species which includes *C. tepiquensis* of the same region.

From tapping cuts in the cortex of *C. spinosus*, latex oozes out in quantity but does not flow sufficiently to permit collection.

Cnidoscolus tenuilobus Lundell, sp. nov. Frutex, 1–2 m. altus, fere estimulosus. Folia petiolata, petiolo ad 21 cm. longo, parce setuloso; lamina ad 20 cm. longa, 30 cm. lata, ad basim cordata, adpresso-setulosa, lobis 5, pinnatifidis, acuminatis. Sepala ♂ puberula, 9–10.5 mm. longa. Stamina 10, 6.5–7.5 mm. longa, biverticillata. Sepala ♀ libera, ca. 7 mm. longa, puberula, stimulosa. Capsula ca. 8 mm. longa, stimulosa. Caruncula 3 mm. lata, basi cordata.

Slender shrub, 1–2 m. high; twigs densely puberulent, practically unarmed, the stinging hairs less than 2 mm. long; pith with transverse plates. Petioles slender, up to 21 cm. long, sparsely setulose with short recurved hairs, densely puberulent at base, glabrous otherwise; gland at apex of petiole fleshy, large, reniform. Leaf-blades broader than long, up to 20 cm. long (from apex of petiole), 30 cm. wide, with broad open round sinus at base, the primary lobes and veins usually 5, sometimes with 2 additional smaller lobes at base, setulose over the entire upper surface with short appressed hairs, setulose along the principal veins on undersurface, sparsely pubescent at base, the margin appressed-setulose, otherwise glabrous; lobes slender, 5–12 mm. wide, cut almost to the base of blade, pinnatified, the secondary lobes slender, less than 15 mm. wide, the primary and secondary lobes with few triangular teeth up to 15 mm. long, the lobes and teeth acute or acuminate. Inflorescence comparatively small, up to 8 cm. across top, the peduncle slender but erect, up to 40 cm. long, puberulent, sparsely but persistently setulose; the primary branches of inflorescence 2 or 3, forked, densely puberulent and setulose. Staminate flowers with greenish calyx, minutely puberulent, 9–10.5 mm. long, the lobes 3–3.5 mm. long, broadly elliptic or ovate-elliptic, the tube large, about 2.5 mm. in diameter at base, gradually expanded above; stamens 10, in two whorls, 6.5–7.5 mm. long; the gland at base shallowly lobed, 1.5 mm. in diameter; lower (outer) stamens with filaments fused scarcely 1 mm. at base, free part of filaments 1.5–2 mm. long, the base of column densely villous for at least 1 mm.; upper (inner) stamens with filaments fused 4–5 mm., free part of filaments 1.5–2 mm. long; anthers up to 1.5 mm. long, the upper slightly smaller; staminodia 3, filiform, up to 4 mm. long. Pistillate flowers solitary in the forks of the branches, pedicellate; calyx 5-lobed to base, greenish, about 7 mm. long, the lobes finely puberulent, setulose with short stinging hairs, linear-oblong, 1.8–2.5 mm. wide; ovary sparsely appressed hairy at base, otherwise glabrous; styles 3, thick, spreading, glabrous, multi-lobed. Capsules subglobose-ellipsoid, about 8 mm. long, beset with short stinging hairs. Seeds gray, inconspicuously mottled with black, obovoid-ellipsoid, about 7 mm. long, 5 mm. wide, base

slightly emarginate, rounded, apex acutish; caruncle fleshy, up to 3 mm. wide, with thick rounded smooth edges, cordate at base, the broad basal lobes extending slightly below the small protruding hilum.

MEXICO: GUERRERO, near Acapulco, kilometer 417 along highway, on roadside ledges, October 20, 1943, *C. L. Lundell & Amelia A. Lundell 12583* (TYPE in the herbarium of Southern Methodist University).

From *C. aconitifolius*, which it approaches, *C. tenuilobus* is distinguished by narrowly lobed pinnatified leaves, appressed setulose upper surface of the leaf blades, setulose calyx lobes of the pistillate flowers, gland at base of androecium 1.5 mm. in diameter (less than 1 mm. wide in *C. aconitifolius*), and by a flat cordate caruncle with rounded smooth edges.

CNIDOSCOLUS TEPIQUENSIS (Cost. & Gall.) McVaugh, Bull. Torrey Club **71**: 466. 1944. *Cnidoscolus tepiquensis* (Cost. & Gall.) Lundell, Field & Lab. **12**: 36. 1944. *Jatropha tepiquensis* Cost. & Gall. Rev. Gen. Bot. **18**: 391. 1906.

MEXICO: NAYARIT, Municipio San Blas, Ejido La Palma, June 14, 1943, *C. L. Lundell & Manuel Itie 12171*, tree, branches verticillate, flowers white; Municipio San Blas, Ejido Aticama, June 15, 1943, *Lundell & Itie 12172*, tree, flowers white; Acaponeta, Ejido San Jose de Gracia, September 21, 1943, *Efraim Hernandez X. s. n.*, tree in fruit. SINALOA, Hacienda Chele, Rancho del Pino, on mountain side, altitude 1500 ft., June, 1943, *Lundell & Itie 12174*, small tree, flowers white. JALISCO, Municipio Puerto Vallarta, on hills above Chimo, in coquital, June 9, 1943, *C. L. Lundell 13035*, tree, 3 in. diameter, 30 ft. high, branches verticillate in threes, bark white, pith solid and continuous in twigs, flowers white, latex white; same locality and date, *Lundell 13036*, tree, 8 in. diameter, 35 ft. high, branches verticillate in threes, pith solid and continuous, flowers white, latex white; Municipio Puerto Vallarta, Arroyo de las Amapas, June 20, 1943, *C. L. Lundell & Rodolfo Gomez s. n.*, flowers white.

C. tepiquensis, of importance as the source of lowland chilte gum, is perhaps the largest tree in the genus, reaching a measured size of 18 inches in diameter and 80 feet high. Trees up to 3 feet in diameter and 100 feet high have been reported from Jalisco. The species has been found as far north as Concordia, Sinaloa, and it ranges through Nayarit into northern Jalisco as far south as Tomatlan. The best stands are in Municipio Puerto Vallarta, Jalisco.

In southern Sinaloa no stands of commercial importance have been located; the trees are found there principally along banks of arroyos and creeks. In Nayarit, approximately 125,000 acres were surveyed in the districts of Ixcuintla, San Blas, and Compostela. In this region, 2 to 2.5 per cent of the area is covered with chilte stands averaging about 40 trees per acre. In the coastal area of Nayarit, the tree is an associate of the *coquito* palm, a species of *Orbignya*. Inland the clearing for agriculture has destroyed most of the virgin forest, so that the species is found chiefly in secondary growth.

In the Municipio Puerto Vallarta, Jalisco, where the *coquito* palm forest has been protected, chilte is one of the dominant elements of the vegetation.

On the seaward slopes of the mountains from Puerto Vallarta to Corrales, there is a continuous belt of the *coquito* palm and *C. tepiquensis*.

C. tepiquensis is the source of all the chilte gum from the Pacific lowlands. It is known as chilte, chilte blanco, and chicle. Although locally exploited over a period of years for use in the manufacture of novelties, commercial exploitation on a large scale did not get underway until 1942. The dry gum has an average rubber content of approximately 30 per cent.

In Sinaloa and Nayarit exploitation has been carried out on a very limited scale, and the stands in Nayarit are practically virgin. The principal source of lowland chilte has been the Municipio Puerto Vallarta in Jalisco; here a production up to 13 tons per week was reached during the 1942–1943 season.

The most accessible stands of Municipio Puerto Vallarta have been excessively tapped. Protuberances cover the trunks where cuts have penetrated through the cambium. Some trees have died and others have sections of the trunk in various stages of decay, but a remarkably large percentage of those severely tapped are healing up.

Tapping has been done in a haphazard manner with various tools. Usually alternate diagonals are slashed on the sides of the tree. The space between these varies greatly depending upon the condition of the trunk. The diagonals usually are not joined, and the latex flows from one to another until it reaches the base of the tree where it is collected in bamboo containers. Tappers have no regular schedule or assigned stands. Inquiries indicate that the trees are retapped at two-week intervals.

The trees give an estimated average yield of about 200 cc. of latex per tapping. The latex coagulates naturally overnight, or immediately upon the addition of water. Gum is prepared for market both in sheet and block form. For the preparation of sheets, blocks are chopped up, the gum pieces placed in hot water until soft, and then laminated. Sheets are shade dried for about three days before packing in henequen sacks.

The stands in the Municipio Puerto Vallarta could yield an estimated 700 tons of gum annually if fully exploited with a rational tapping system. A production of at least 200 tons annually should be possible from the stands in Nayarit and Sinaloa.

With continued unregulated exploitation, the wild stand of *C. tepiquensis* will be decimated within a decade.

Cnidoscolus tomentosus Lundell, sp. nov. Frutex, hirtellus et stimulosus. Folia petiolata, petiolo ad 9.5 cm. longo; lamina ad 12 cm. longa, 16 cm. lata, cordata, supra pilosa, subtus tomentosa, lobis 3 vel 5, paucidentatis. Inflorescentiae parvae. Capsula 1.6 cm. longa, stimulosa. Semina 10.5–11.5 mm. longa, 7–8 mm. lata. Caruncula 3.5–4.5 mm. lata.

Shrub; twigs stout, densely hirtellous at first, armed with stinging hairs up to 5 mm. long; pith with transverse plates. Petioles stout, costate, shorter

than the blade, up to 9.5 cm. long; the gland at apex of petiole fleshy, conspicuous, suborbicular. Leaf-blades broader than long, up to 12 cm. long (from apex of petiole), 16 cm. wide, the basal sinus rounded, open, the primary lobes and veins 3 or 5, usually 5, densely pilose on upper surface, tomentose on lower surface, with scattered short stinging hairs on upper surface and along margin, the stinging hairs absent on undersurface at maturity; the lobes extending to middle of blade, oblong or obovate-oblong, the margin of lobes subentire or dentate with 1–several remote acuminate teeth, the teeth up to 1 cm. long, mostly above middle of lobes, and at base of blade. Inflorescence (in fruit) small, 6 cm. wide, the peduncle thick, 11 cm. long, densely hirtellous, the short stinging hairs few and scattered; the primary branches 2, forked, with indument like that of peduncle. Staminate and pistillate flowers not seen. Capsules about 1.6 cm. long, sparsely pubescent, beset with short stinging hairs. Seeds oblong-ellipsoid, somewhat flattened, 10.5–11.5 mm. long, 7–8 mm. wide, conspicuously mottled at first, nearly black at maturity, truncate and slightly emarginate at base, acutish at apex; caruncle fleshy, large, 3.5–4.5 mm. wide, with two triangular wings, cordate at base, extending to below the small depressed hilum.

MEXICO: OAXACA, Santa María del Tule, October 17, 1943, *Efraim Hernandez X. s. n.* (TYPE in the herbarium of Southern Methodist University); vernacular name, *mala mujer*.

C. tomentosus was collected in the same locality as *C. Hernandezii*, and bears a resemblance to that species. It differs at once in having petioles glandular at apex, larger seeds with dissimilar caruncle, and sparsely pubescent capsules.

Cnidoscolus velutinus Lundell, sp. nov. Frutex, ca. 4 m. altus, pilosus et stimulosus. Folia longe petiolata, petiolo ad 37 cm. longo, stimuloso; lamina cordata, ad 28 cm. longa, 43 cm. lata, velutina, lobis 5, obovatis, remote dentatis. Sepala ♂ velutina, alba, 14–17 mm. longa. Stamina 10, 9–11 mm. longa, biverticillata. Sepala ♀ velutina, libera, 8–12 mm. longa, ad 5 mm. lata. Ovarium pubescens. Capsula ca. 12 mm. longa. Semina oblongo-ellipsoidea, ca. 9 mm. longa, 5.5 mm. lata. Caruncula 3 mm. lata, basi cordata.

Shrub, about 4 m. high; twigs thick, short pilose and beset with slender stinging hairs up to 5 mm. long; pith with transverse plates. Petioles stout, costate, pilose with rather firm hairs, beset with stinging hairs, up to 37 cm. long; gland at apex fleshy, shallowly lobed. Leaf-blades up to 28 cm. long (from apex of petiole), up to 43 cm. wide, deeply cordate at base, the sinus broad and rounded, the primary lobes 5, persistently velutinous on both surfaces with soft short hairs, the indument dense on lower surface, beset with few scattered hairs on upper surface and along margin; lobed to below the middle of blade, the apical lobes obovate, cuspidate, the sinuses narrow but rounded and open, the margin of upper two-thirds of lobes cuspidate-dentate with rather remote conspicuous teeth, the base of lobes dentate with smaller remote acute teeth. Inflorescence 4–13 cm. wide, the peduncle stout, 7.5–21 cm. long, the peduncle and branches densely velutinous, beset with few scattered stinging hairs or unarmed. Staminate flowers white; calyx velutinous, 14–17 mm. long, the tube comparatively slender, lobes short, broadly ovate-elliptic; stamens 10, in two whorls, 9–11 mm. long, basal 1.5 mm. of staminal column pubescent; lower (outer) stamens with filaments fused for 4 mm., free part of filaments about 2.5 mm. long; upper (inner)

stamens with filaments fused for 6 mm., free part of filaments about 3 mm. long; anthers 2.2–4 mm. long; staminodia 3, filiform, 4.5 mm. long. Pistillate flowers solitary in the forks of the branches, rarely geminate, pedicellate; calyx velutinous, lobed to the base, the lobes oblong or oblong-elliptic, 8–12 mm. long, up to 5 mm. wide; ovary yellow, pubescent; styles united at base, multilobed, sparsely hirtellous. Capsules broadly ellipsoid, about 12 mm. long, pubescent and beset with stinging hairs. Seeds brown, oblong-ellipsoid, slightly wider above center, about 9 mm. long, 5.5 mm. wide, with a narrow but conspicuous dorsal ridge, apex acutish; caruncle fleshy, 3 mm. wide, cordate at base, the lobes extending to or below hilum, the margin thick and smooth.

MEXICO: GUERRERO, near Xaltianguis, kilometer 407 of highway, on mountain side, October 20, 1943, *C. L. Lundell & Amelia A. Lundell 12592* (TYPE in the herbarium of Southern Methodist University).

Lundell & Lundell 12592 agrees rather closely with the brief original description of *C. multilobus*, but differs significantly in technical details from the interpretation of the species by McVaugh (1943). Since the more detailed study of McVaugh presumably is based upon a reinterpretation of type material, there is ample reason for considering that an undescribed species is represented.

The caruncle of *C. velutinus*, cordate at base and with thick rounded edges, is altogether different from the caruncle described and figured by McVaugh (1943, fig. 13) for *C. multilobus*.

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